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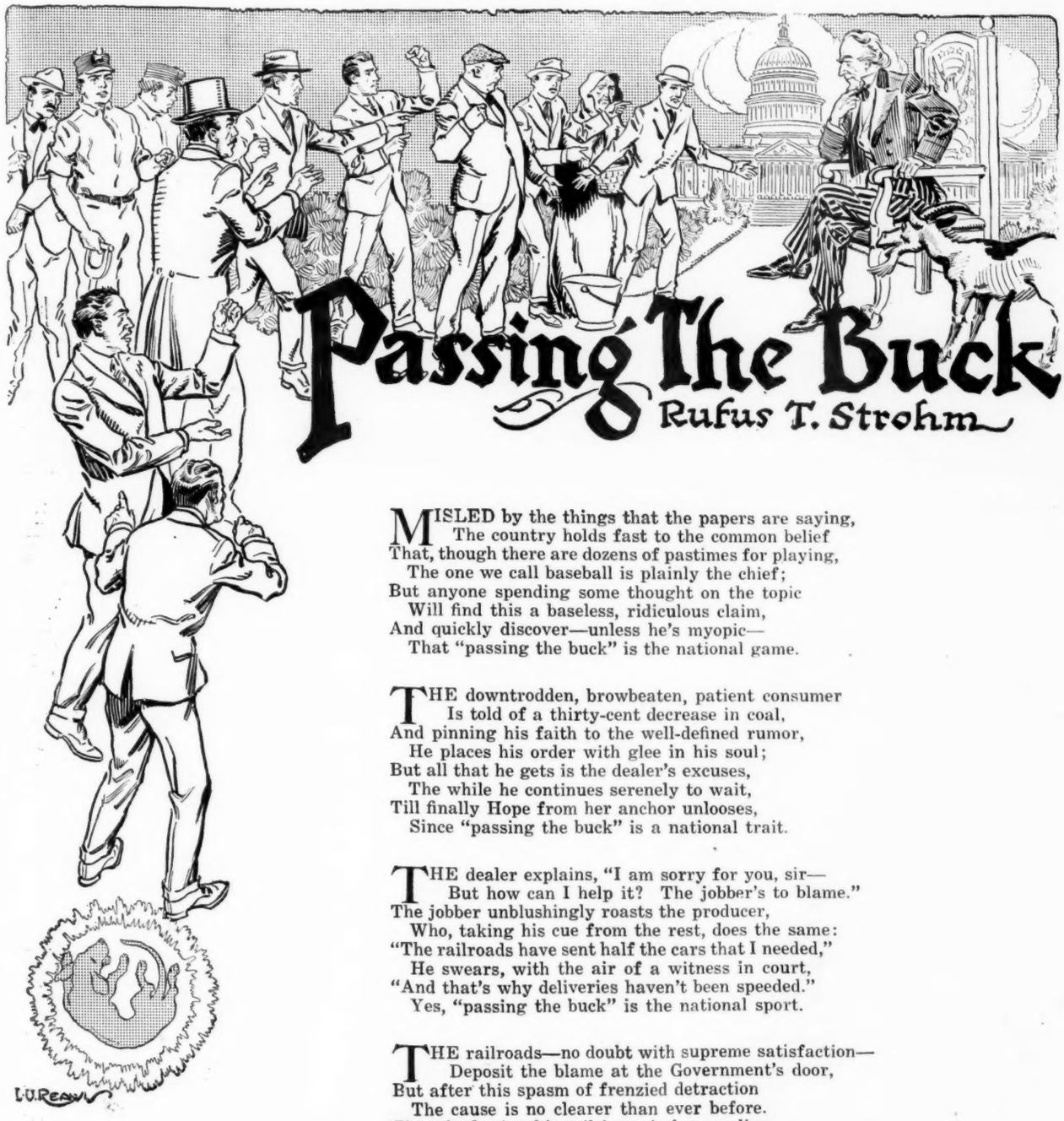


Passing The Buck

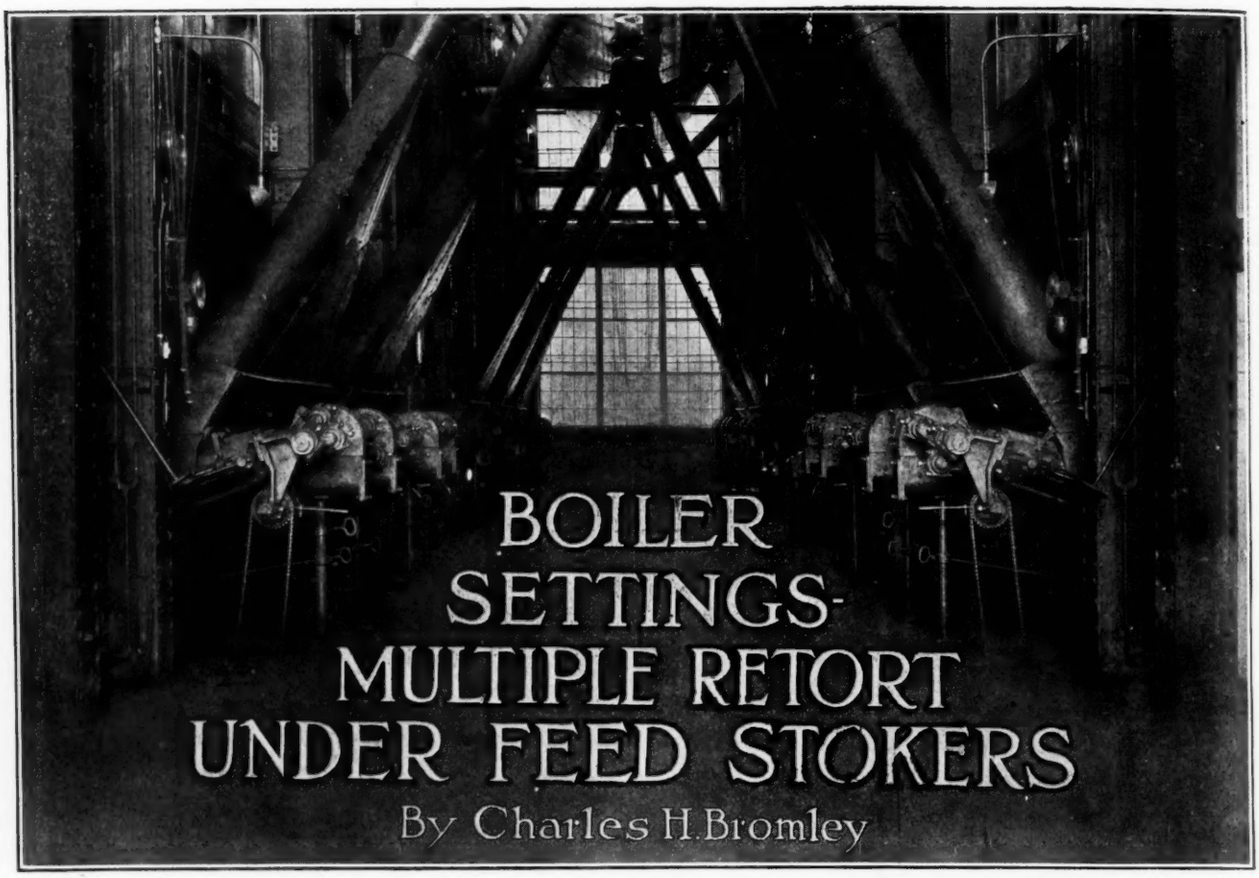
Rufus T. Strohm

MISLED by the things that the papers are saying,
The country holds fast to the common belief
That, though there are dozens of pastimes for playing,
The one we call baseball is plainly the chief;
But anyone spending some thought on the topic
Will find this a baseless, ridiculous claim,
And quickly discover—unless he's myopic—
That "passing the buck" is the national game.

THE downtrodden, browbeaten, patient consumer
Is told of a thirty-cent decrease in coal,
And pinning his faith to the well-defined rumor,
He places his order with glee in his soul;
But all that he gets is the dealer's excuses,
The while he continues serenely to wait,
Till finally Hope from her anchor unlooses,
Since "passing the buck" is a national trait.

THE dealer explains, "I am sorry for you, sir—
But how can I help it? The jobber's to blame."
The jobber unblushingly roasts the producer,
Who, taking his cue from the rest, does the same:
"The railroads have sent half the cars that I needed,"
He swears, with the air of a witness in court,
"And that's why deliveries haven't been speeded."
Yes, "passing the buck" is the national sport.

THE railroads—no doubt with supreme satisfaction—
Deposit the blame at the Government's door,
But after this spasm of frenzied detraction
The cause is no clearer than ever before.
Though chasing his tail in a circle unending
May add to the canine's existence a spice,
In man it's a habit that promptly needs mending,
For "passing the buck" is a national vice.



BOILER SETTINGS-MULTIPLE RETORT UNDER FEED STOKERS

By Charles H. Bromley

One of several articles intended primarily to help those of the Middle West burn their high-volatile, high-ash coals instead of the high-grade Eastern coals now denied them by the Fuel Administration's Zone System for the distribution of bituminous coal. This article treats of the latest and best practice in boiler settings for the multiple-retort underfeed stoker.

THREE makes of multiple-retort, inclined underfeed stokers are available—the Westinghouse, the Taylor and the Riley. Compared with boiler settings for all other stokers, settings for multiple-retort underfeed stokers differ in that only in the most exceptional cases are arches used; the furnace volume is usually greater owing to high rates of combustion. Coking arches are not needed because the fresh coal is supplied from beneath the active or incandescent zone, the volatile passing through this zone before getting into the space above the fuel bed. Combustion arches or mixing arches and wing walls are rarely if ever employed, owing, it is likely, to the character of the fuel bed, being thick and such as to give good mixture of air and gases in the fuel bed itself. This is present practice. It may develop, however, for the large cross-drum boilers, which present such large volume immediately above the fuel bed, that an arch extending from the rear out over the fuel bed will give better combustion results at high ratings, and these boilers are now widely installed in plants subject to peak loads and high combustion rates. Whatever air may sweep up at the refuse end of the stoker would then be deflected and compelled to mix with the richer gases coming from the remainder of the fuel bed. This is merely a suggestion. Someone may try it out, getting data on performances with various combustion rates and with coals of different volatile and moisture content.

Figs. 1 and 2 represent the most recent practice in boiler settings for underfeed stokers. Very large combustion volume is obtained. Notice that in Fig. 1 the stoker is set under the low end of the boiler, the bottom of the headers (front) are 9 ft. 8½ in. from the floor. The back headers are 15 ft. above the floor, and the gases travel a mean of about 14 ft. before they impinge on the heating surface.

The outstanding feature of these settings, other than the great volume of the furnace, are the doors in the bridge-wall, making it reasonably convenient to get at the clinker from the rear instead of from the side. The latter location makes it necessary to use a very long and heavy bar to break up or move the clinker. These doors in the bridge-wall make it convenient to pass materials for repair into the furnace.

Now that these settings are being favorably received, we may see the development carried further to include, in the large plant particularly, continuous rotary ash discharge and the location of all stoker and draft-control apparatus, also instrument boards, located at what we now consider the back of the boilers. We see this being done at the L Street Station of the Edison Illuminating

*For previous articles see the following issues of "Power": "Zone System for the Distribution of Bituminous Coal," May 14, 1918. "Coals of the United States," May 21, 1918. "Boiler Settings," May 28, 1918. "Boiler Settings—Chain-Grate Stokers," June 4, 1918.

Co., Boston. Clinker grinders for these large boilers form too broad a subject for discussion here; but the writer now has in preparation an article treating of these and which will be published in *Power*.

There is a tendency even in new plants to make ash-pits too shallow and too narrow. Those in Figs. 1 and 2 are of good size, it will be noticed, being about 6 ft. wide by 8 ft. deep and as wide as the furnace. Note that the ash-hopper outlet opening is very large. There is sufficient headroom for the man working at the bridge-wall doors, the distance from the floor to the supporting I-beams being 6½ ft. Note that the forced-draft fan is connected directly to the wind-box. Of course, this is not always possible; but it is highly desirable.

It is usual with this setting to place the tile on top of the lower row of tubes.

Fig. 2 shows the setting for a Connelly boiler recently installed for the Denver Gas and Electric Co., Denver, Colo. The fuel used is Colorado lignite. Typical analyses of this fuel give the following: Moisture, 18.62 per cent.; volatile, 40.70 per cent.; fixed carbon, 34.17 per cent.; ash, 6.51 per cent. The B.t.u. as fired usually average 9770; dry, the lignite will give 10,000 to 12,000 B.t.u. per pound.

The height of the settings of boilers of this type is invariably measured from the center of the bottom or mud drum to the floor line. In this setting this distance is 11 ft. 2 in.—an extraordinary height. The old and usual practice was to set these boilers 5 ft. 6 in.; then 7 ft. 6 in. became not unusual, and 8 ft. 6 in. is getting to be common for underfeed stokers, at least, using Illinois and other Middle Western coals.

AVERAGE ANALYSIS OF FIVE CLASSES OF COAL

	Per Cent.
Eastern Coal (West Virginia):	
Moisture	2.0
Volatile	19.0
Fixed carbon	71.0
Ash	8.0
Sulphur	1.5
B.t.u. per lb.	14,200 and above
Youghiogheny Coal:	
Moisture	4.0
Volatile	30.0
Fixed carbon	55.0
Ash	11.0
Sulphur	1.7
B.t.u. per lb.	13,000 to 13,500
Pittsburgh Coal:	
Moisture	3.0
Volatile	32.0
Fixed carbon	56.0
Ash	9.0
Sulphur	1.5
B.t.u. per lb.	13,500 to 14,200
Middle Western Coal:	
Moisture	14.0
Volatile	35.0
Fixed carbon	45.0
Ash	20.0
Sulphur	3.0
B.t.u. per lb.	12,500–11,300 and less
Lignite Coal:	
Moisture	20 to 35
Volatile	40 to 50
Fixed carbon	40 to 50
Ash	10 to 20
B.t.u. per lb., dry	10,000 to 12,000

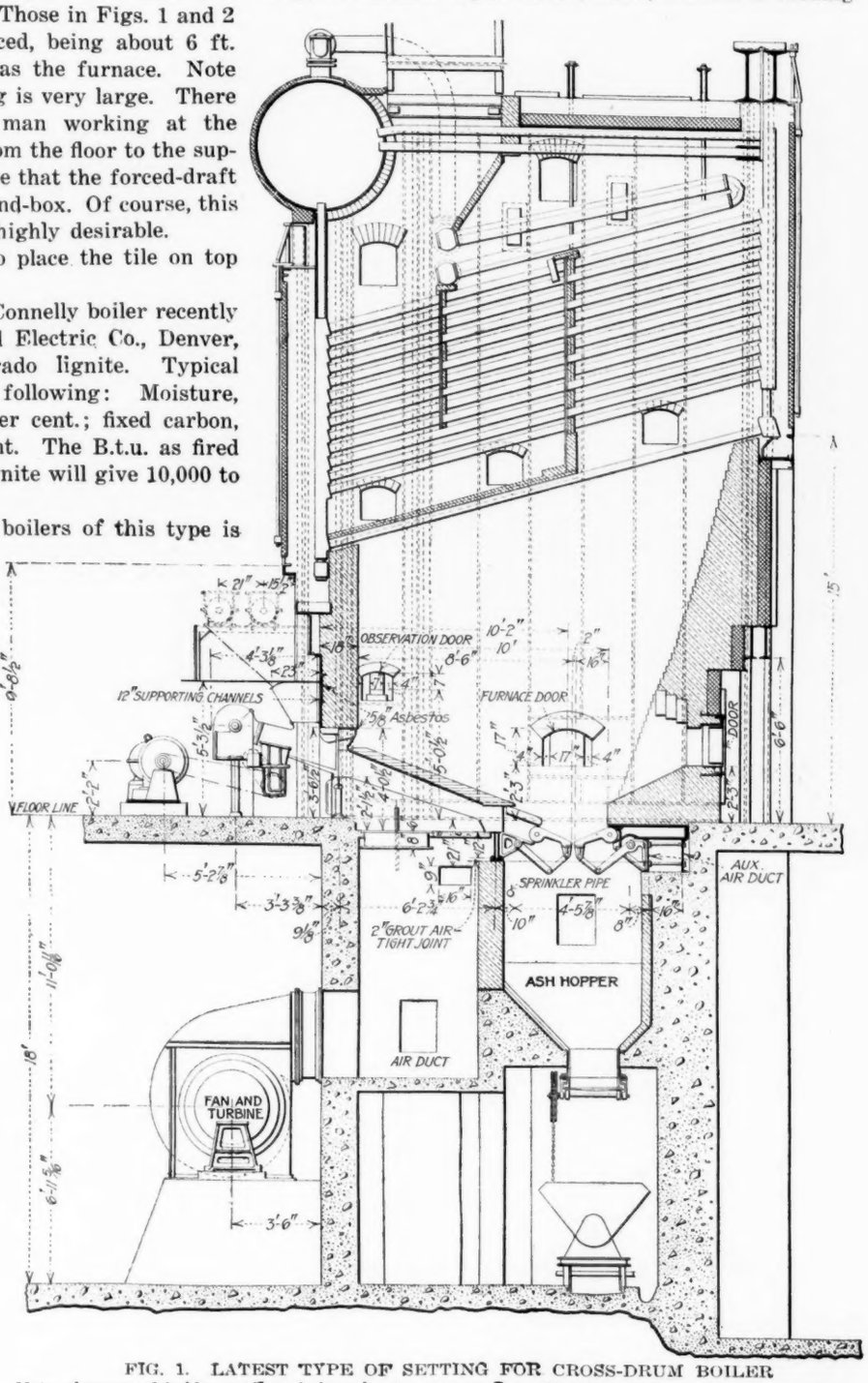


FIG. 1. LATEST TYPE OF SETTING FOR CROSS-DRUM BOILER
Note absence of bridge-wall and door in the rear wall making the clinker on the dump plate easily accessible

It is found that the five classes of coal given in the table require different sizes of combustion volume for the most economical combustion through the usual ranges of combustion rates.

The factors having the greatest influence are: First, percentage of volatile matter and the composition of the hydrocarbons given off during the distillation period, and temperatures of distillation, which vary with the different coals; second, combustion rate per square foot of grate surface or per retort; third, method of feeding the coal into the furnace, that is, overfeed or underfeed; fourth, air supply below and above the fuel bed. The extent of the influence of these were treated of in the article, "Boiler Settings," *Power*, May 28, 1918, and more fully in the Apr. 23 issue, page 596; little need be said here about them.

The underfeed stoker owes much of its success with

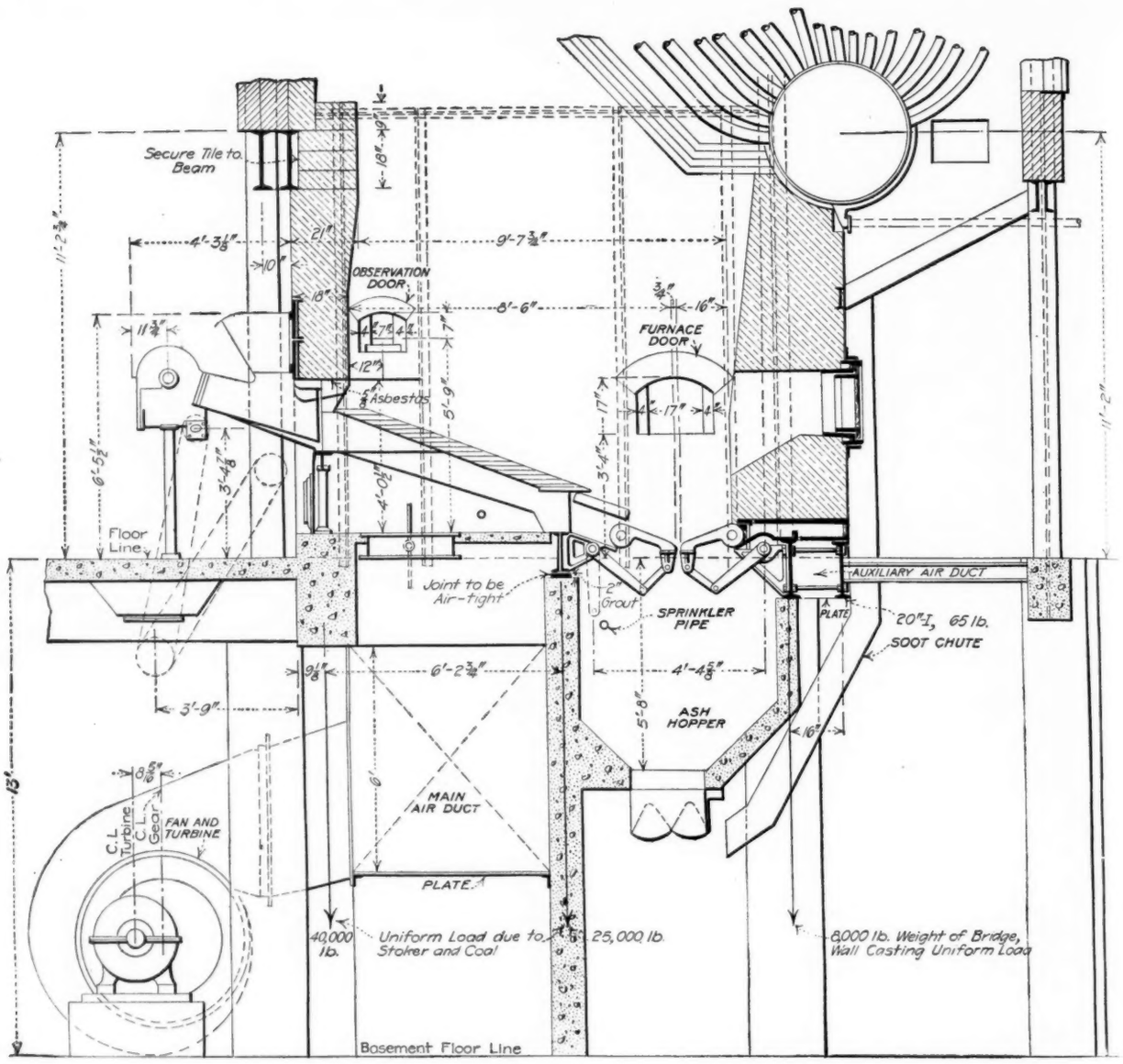


FIG. 2. SETTING FOR A CONNELLY BOILER RECENTLY INSTALLED TO BURN COLORADO LIGNITE

Note the extraordinary height of the setting, 11 ft. 2 in. The bridge-wall is eliminated and the rear wall provided with doors. This setting is showing results that will mean much to the utilization of lignite in large power stations

high-volatile coals to the deep fuel bed, which at ordinary combustion rates has a temperature of 3000 deg. F. up through which zone the volatile gases must pass. But this is the vital advantage—the supply of air and the distribution through the fuel bed enable the volatile gases to get adequate oxygen before and while passing through the fuel bed, otherwise this extremely high temperature would break up the hydrocarbons, throwing down soot which, we now know, is so exceedingly difficult to burn once it is formed. This feature of combustion in boiler furnaces is worth one's attention, and it is well set forth in Bureau of Mines Bulletin 135, recently printed. The unfortunate thing is that this bulletin did not deal with chain-grate stokers and multiple-retort underfeed stokers, instead of with but one type of overfeed stoker.

Although Fig. 2 was designed for lignite, no mistake would be made by using a similar setting for any Middle

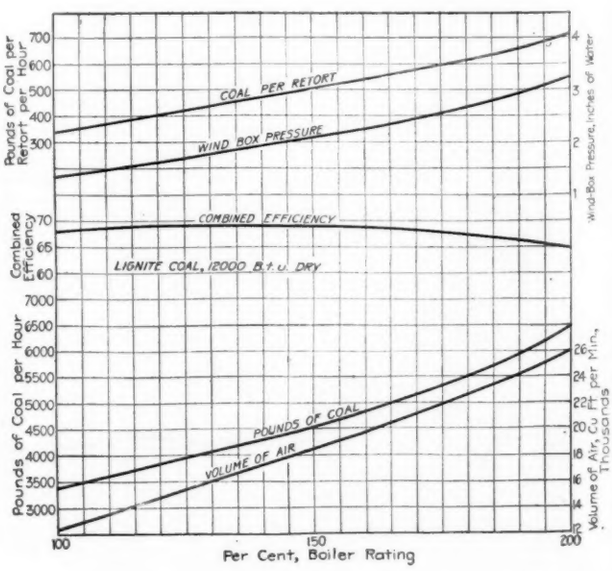

Pounds of Coal per Retort per Hour
COAL PER RETORT
WIND BOX PRESSURE
Wind-Box Pressure, Inches of Water
Combined Efficiency
COMBINED EFFICIENCY
LIGNITE COAL, 12000 B.t.u. DRY
Pounds of Coal per Hour
POUNDS OF COAL
VOLUME OF AIR
Volume of Air, Cu. Ft. per Min., Thousands
Per Cent, Boiler Rating

FIG. 3. PERFORMANCE CURVES OF THE STOKER AND SETTING SHOWN IN FIG. 2

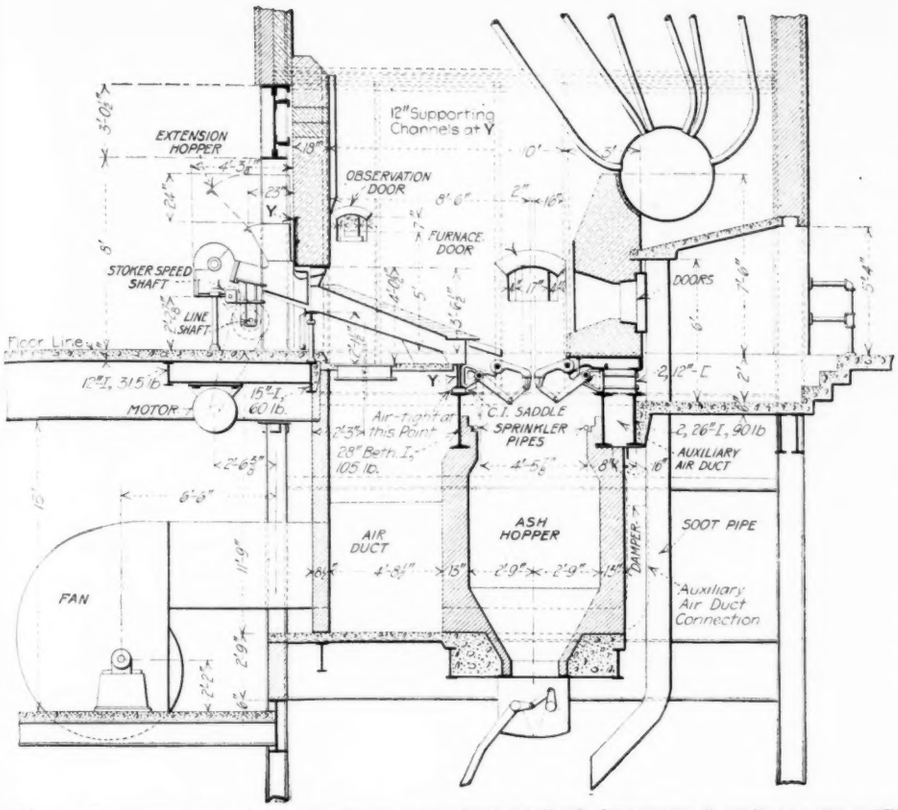


FIG. 4. SETTING FOR A CLASS M 55 STIRLING BOILER RECENTLY INSTALLED FOR THE GOVERNMENT

This setting is worthy of study; it embodies the most recent practices. The setting is 7 ft. 6 in. high with doors in the rear wall. Note the large ashpit. A high-grade low-volatile coal is burned

Western coal, particularly if high combustion rates are employed. Settings for boilers of this type with 7 ft. 6 in. between center of mud drum and floor line are giving good results with Middle Western coal.

Because the underfeed stoker has been so little used for lignite, it is interesting to see what this installation is expected to do with this fuel. Fig. 3 shows the calculated performance curves for this installation. One is impressed by the flat combined efficiency curve, which, at 200 per cent. boiler rating, is down only to 65 per cent. Here 720 lb. of coal per retort per hour is being burned, with a wind-box static pressure of 3.5 in. of water. A study of all the curves will be found interesting; space here permits of doing little more than showing them.

Lignite is a peculiar fuel in the furnace. It is fragile and much of it becomes very fine, like sand, when it gets near the dump grate. Usually the space between the closing edges of the front and back dump grates is, in this stoker, 2 in. Notice that in Fig. 2 it is made $\frac{3}{4}$ in. to prevent the lignite running out in a stream, which it would do if the space were 2 inches.

Fig. 4 shows a recent setting for a Class M 55 Stirling boiler to which considerable thought was given before deciding on the various measurements. A high-grade, low-volatile Eastern coal will be used. The plant in which this setting is used was recently built for the Government.

Fig. 5 shows one of the most recent settings for the B. & W. type boiler. The boiler is set with the bottom of the front header 13 ft. 6 in. from the floor. There are two doors in the bridge-wall, as in Figs. 1 and 2. The bridge-wall is, of course, located farther from the boiler front wall than it is in the common three-pass setting, tile covering the lower row between the vertical baffle and bridge-wall.

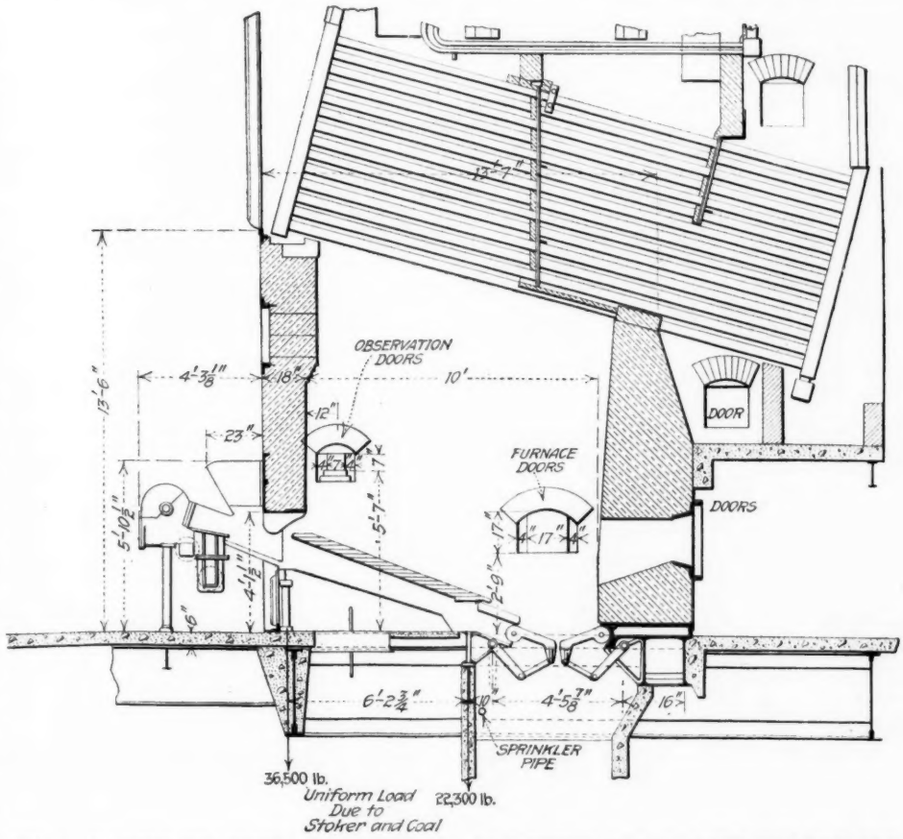


FIG. 5. LATEST PRACTICE (NOT GENERAL) IN SETTING B. & W. TYPE BOILERS FOR HIGH COMBUSTION RATES

Note that the boiler is set 13 ft. 6 in. above the floor, giving an extraordinarily voluminous furnace. Doors are provided in the rear wall. An attempt is made to obtain uniform gas velocity through the three passes

This setting is in New York State; and a similar one, except that the boiler is set 14 ft. high, has been installed in Connecticut.

A setting with a "leaning" front wall, which has given a good account of itself, is shown in Fig. 6. It is

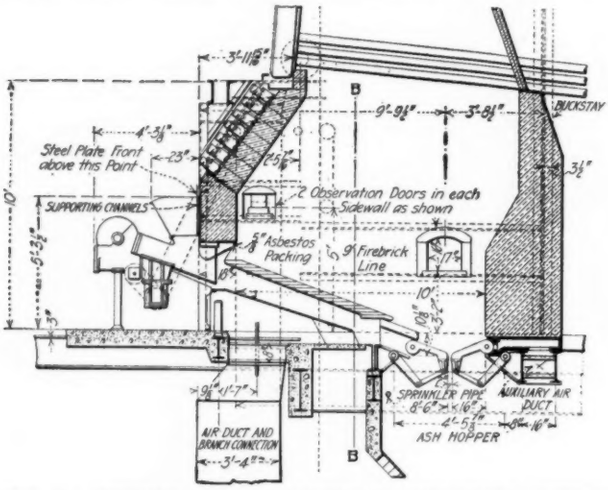


FIG. 6. SETTING WITH LEANING FRONT WALL, GIVING GOOD ACCOUNT OF ITSELF BURNING MIDDLE WESTERN COAL—LOCATION, ST. LOUIS

Fig. 9 shows a large, roomy setting for a Wickes boiler. It is found that good operating results depend much upon the area of the opening at the end of the furnace; that is, between the bridge-wall and arch. For the ordinary setting 12 ft. wide the opening should be

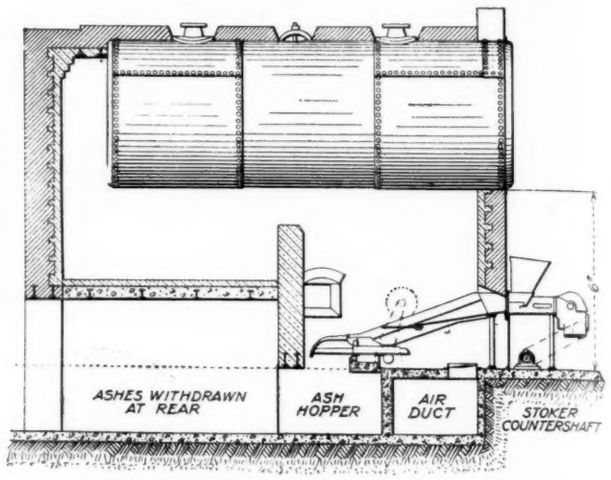


FIG. 7. MINIMUM DESIRABLE HEIGHT FOR HORIZONTAL TUBULAR BOILER WITH MULTIPLE-RETORT UNDERFEED STOKER

installed in the comparatively new station of the Union Electric Light and Power Co., St. Louis, and burns Middle Western coal. The setting shown in Fig. 8 is interesting and typical of settings modified for the underfeed type of stoker, though originally designed for others or for none at all. Usually the headroom is fixed, and to get sufficient combustion volume the stoker must be set "on the floor." This stoker uses Illinois coal, and as the bottom of the front header is but 8 ft. above the floor, combustion is much better for any given rating above builders' than it would be if the stoker was not lowered about 20 in. below the usual height from the floor. Greater combustion volume is necessary.

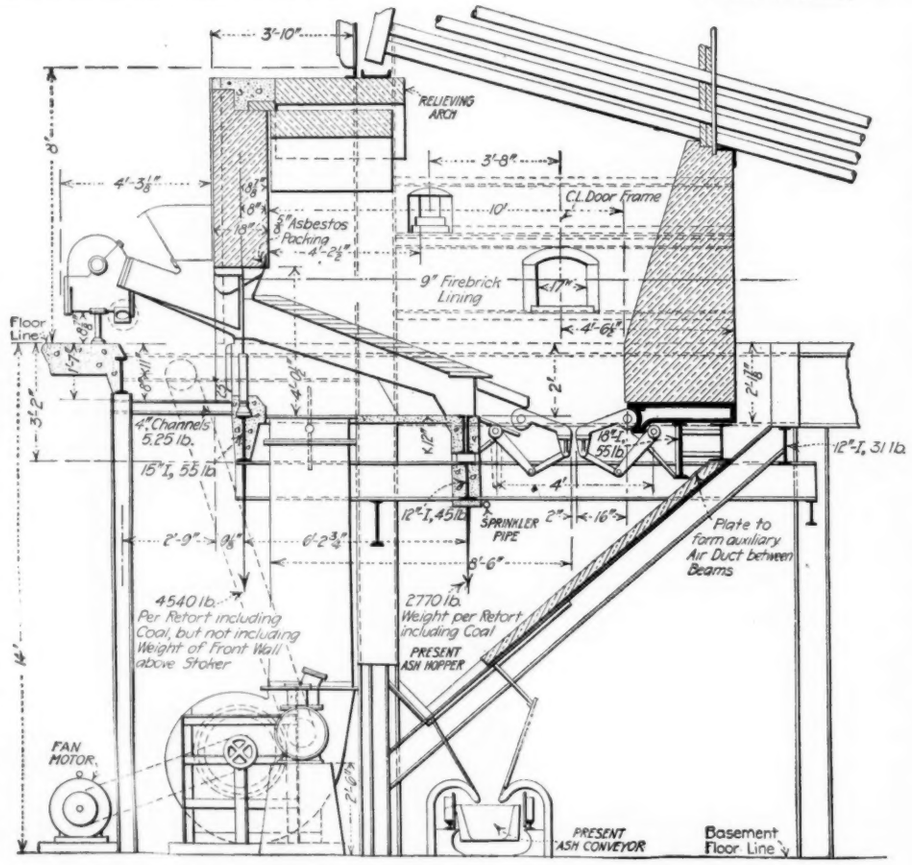

RELIEVING ARCH
Asbestos Packing
C.L. Door Frame
9" Firebrick Lining
Floor Line
4" Channels 5.25 lb.
15" I, 55 lb.
12" I, 45 lb.
12" I, 31 lb.
SPRINKLER PIPE
Plate to form auxiliary Air Duct between Beams
4540 lb. Per Retort including Coal, but not including Weight of Front Wall above Stoker
2770 lb. Weight per Retort including Coal
PRESENT ASH HOPPER
FAN MOTOR
PRESENT ASH CONVEYOR
Basement Floor Line

FIG. 8. CHAIN-GRATE SETTING MODIFIED FOR MULTIPLE-RETORT UNDERFEED STOKER

Where such changes are made higher combustion rates are the objects sought. The combustion volume usually must be increased to obtain efficiency; the headroom is invariably fixed, therefore the stoker must be lowered to give the added combustion volume

at least 8 ft. Anything less will give a restricted passage for the gases, especially if the boiler must be forced, on account of too little area between the tubes. Settings for an Erie City boiler and those of similar type differ but little from Fig. 9. Fig. 7 shows a Riley stoker under a return tubular boiler. The height of the setting, 6 ft., should be considered as a minimum for good practice. Note the ash hopper location and the openings for the withdrawal of the ashes. The need of more attention to adequate furnace volume and means of mixing air and combustible gases is manifest in stoker development, as regards coal burning capacity. This is particularly true of the high volatile coals of the

Middle West which require considerably more combustion volume for a given combustion rate and completeness of combustion than do Pocahontas and Pittsburgh coals. The B type Taylor stoker for example has very great retort capacity and is fed by triple plungers. This stoker is capable of burning 1500 lb. of coal per retort per hour, the efficiency being appreciably higher than the smaller Taylors at high combustion rates. Of course, these stokers are adapted particularly to low-grade fuels where high combustion rates are necessary. For these stokers the boiler settings should give adequate combustion volume.

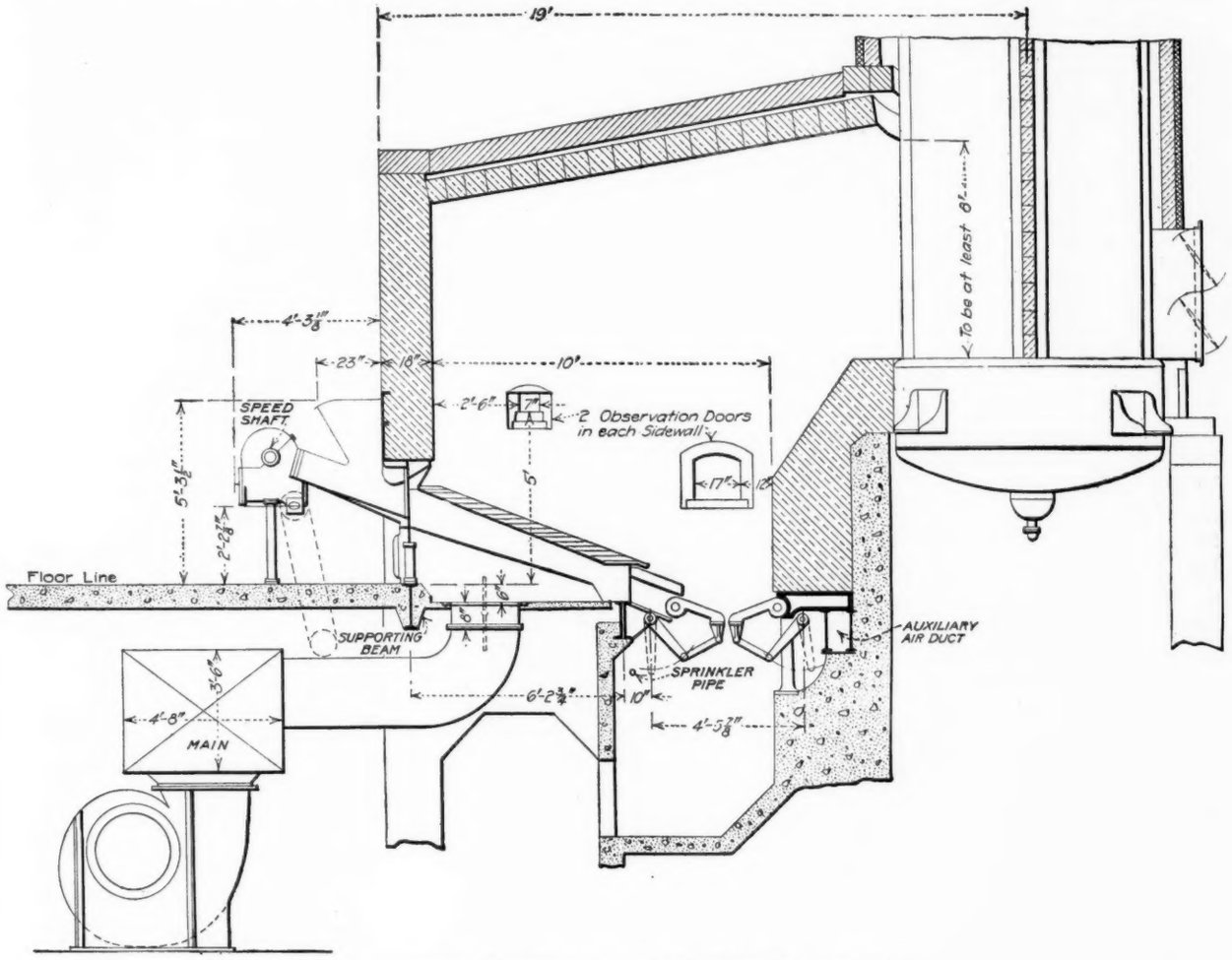


FIG. 9. ROOMY SETTING FOR WICKES TYPE OF BOILER

Experience shows that for the best results the opening into the bank of tubes must be large. It should bear some ratio to the active grate surface of the stoker; but no definite ratio has been determined; the aim is to avoid a too small area which would seriously affect draft loss and gas velocity

In the East it is rare that one gets coal containing more than 30 per cent. volatile, and for such coal and with boiler ratings up to 250 per cent. builder's rating, a 12-ft setting for any B. & W. type boiler gives satisfactory results. For Stirling and Connelly boilers settings giving 7 ft. 6 in. to 8 ft. 6 in. from center of bottom drum to the floor allow of very high combustion rates—500 lb. and up per retort per hour—with excellent combined boiler and furnace efficiency. For Illinois and other Middle Western coals 14-ft. settings for B. & W. type boilers are not a bit too high, particularly where the boilers must at times be forced, and 8 ft. 6 in. for the Stirling and the Connelly boilers would be used as a minimum by the writer, provided of course serious obstacles did not compel setting them lower.

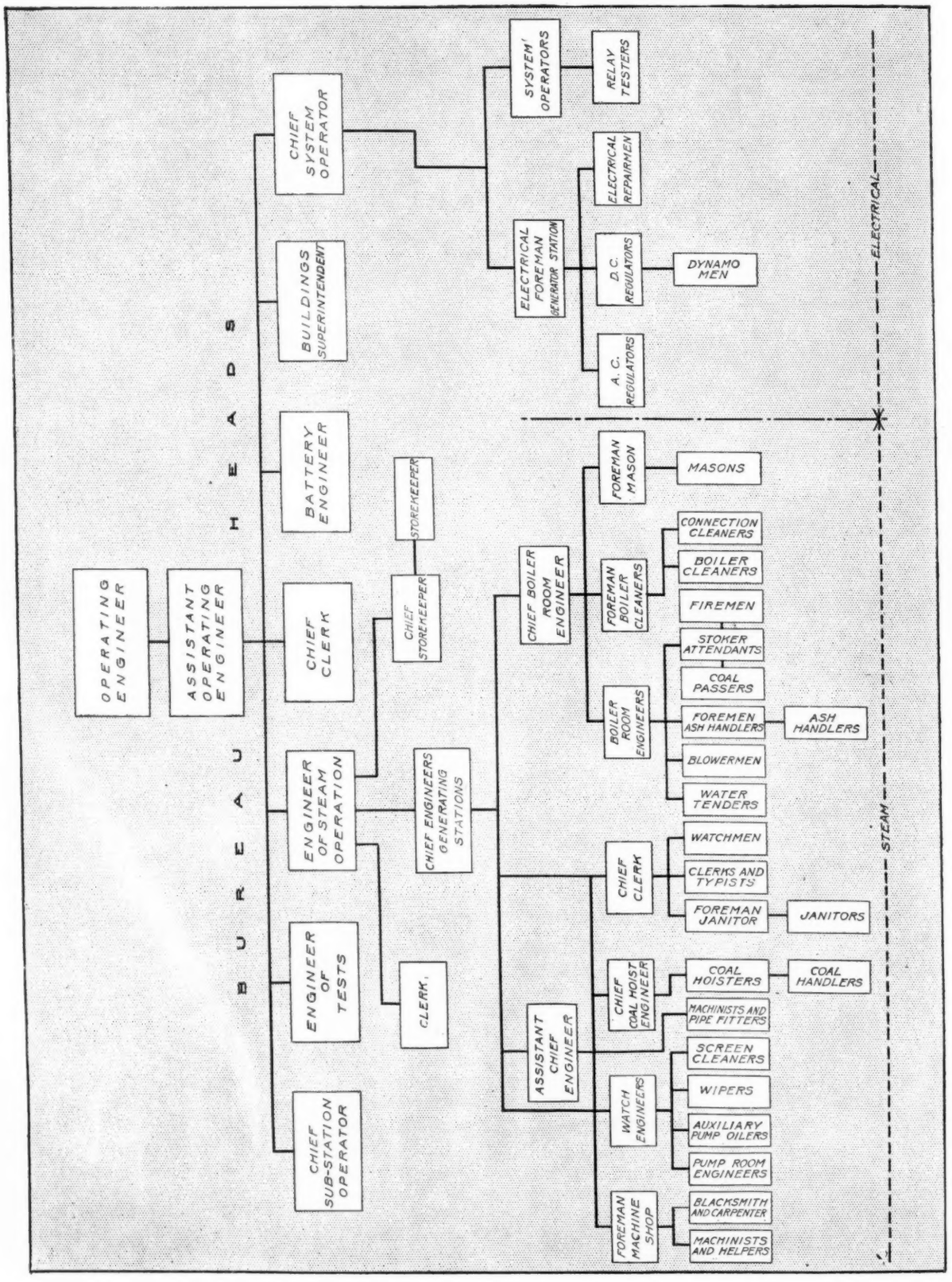
The writer desires to express his appreciation of the assistance given him by J. G. Worker, manager, and E. L. Lundgren, chief engineer, stoker department, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., in the preparation of this article.

Because it was found that in the maintenance of a steam exhaust pipe in connection with a steam-power plant quantities of steam and moisture found their way into plaintiff's near-by house, the Kansas City Court of Appeals has affirmed judgment for $750 damages in favor of plaintiff in the case of Stremph vs. Loethen, 203 Southwestern Reporter, 238.

It is found by the court that by reason of the proximity of the pipe to plaintiff's property it naturally caused injury to the property and annoyance to plaintiff. The decision recognizes that what is known in law as a "prescriptive right" (that is, a right based on long continued exercise under such circumstances as to imply consent by affected property owners) may be acquired for the continuance of a nuisance of this kind, but the court holds that before such right will be held to have arisen, it must appear that the use has continued for at least ten years, in substantially the same way and with equally injurious results.

Power-Station Organization Chart

The chart shown below illustrates how the engineering department of the Edison Electric Illuminating Co., of Brooklyn, N. Y., is organized. Note that there are seven bureau heads who are responsible for the operation and maintenance of equipment. The chief engineer of operation, it will be noticed, is responsible for the electrical as well as the steam and mechanical divisions of the work in and about the power stations.



Induction Motor Troubles—I

BY GORDON FOX

Induction motors are, in their structural features, the most simple of all electric motors. They are consequently notable for their general freedom from trouble. Nevertheless they are not invulnerable, requiring care in application and attention in service to insure satisfactory performance. In this article troubles occurring outside of the motor are discussed.

INDUCTION motors being inherently simple, a considerable percentage of their troubles may be traced to causes aside from the motor; namely, faults in the current supply or errors in application. The performance of an induction motor may be materially affected by a change in the voltage at its terminals. Both the starting torque and the maximum, or pull-out, torque vary as the square of the impressed voltage. If the voltage is 20 per cent. low, the maximum torque will be about two-thirds normal value. With a varying load this reduction may be sufficient to render the motor incapable of handling the peaks. Low voltage may arise either from excessive line drop or trouble at the source of supply. One instance in mind is where a large number of small induction motors, lightly loaded, were fed by a small alternator in an isolated plant. The power factor was so low that the alternator could not be sufficiently excited to maintain its voltage. Whenever a large elevator motor was started, the generator's voltage was further reduced and the motors in the plant would stall.

Reactance an Appreciable Factor

In another instance a number of low-voltage motors were fed by a transmission line about a half-mile in length. The low transmission voltage selected meant that heavy currents must be carried. The transmission line installed was of sufficient carrying capacity and low enough resistance, but the reactance of the line had not been considered. Reactance becomes a very appreciable factor when large currents are involved. In this case the reactance was more than twice the resistance of the line. The result was, of course, low voltage at the motors and frequent stalling. A large increase in copper would have been required to sufficiently reduce the impedance in this case, and it was found to be cheaper to transform and transmit at a higher voltage.

Squirrel-cage induction motors are commonly started with reduced primary voltage. If the reduced voltage is secured through the use of autotransformers, a number of taps are generally provided, rendering it possible to select a starting voltage sufficient to produce the desired motor-starting torque. If middle-voltage taps of the supply transformers are used to provide reduced starting voltage, it is evident that but one-quarter full-voltage starting torque is available. This arrangement, therefore, may not be feasible where heavy starting duty is to be met. The star-delta starting scheme involves the application of 73 per cent. of running voltage across the windings at starting. The torque is about one-half full-voltage value and is ordinarily sufficient but occasionally deficient.

Overvoltage is a much less frequent offender than undervoltage. Most motors will successfully withstand 10 per cent. overvoltage without serious results. The magnetizing current is increased, lowering the power factor and increasing the iron losses and raising the temperature of the machine, at the same time increasing the pull-out torque. Overvoltage is more frequently met in the form of incorrect winding, not suited to the voltage supplied. This possibility will be considered under the heading of winding faults.

Unbalanced Voltage a Cause of Trouble

Unbalanced voltage is not an infrequent condition. The use of transformers of differing ratios in a bank, an inexact Scott connection or unbalancing through single-phase lighting or welding load may cause its occurrence. A three-phase induction motor may be conceived as three single-phase transformers having a common secondary. With this conception it is evident that an unbalanced primary voltage will result in unbalanced load, and circulating currents flowing which tend to equalize the primary voltage. In fact, induction motors running light might actually be used to equalize the voltages on unbalanced lines. The result of circulating currents in the ordinary case is overheating of the motor. If the unbalancing is at all severe, the motor may heat up, even without load; if not severe, heating above normal may be traceable to this condition.

Sometimes a two-phase or a three-phase motor may be caused accidentally to operate single-phase. Such a condition may arise through blowing of one fuse at the supply transformers or at the motor, or through faulty contact in one lead on the running side of the starting switch or compensator, the starting side of which is in good condition. A polyphase induction motor will not start single-phase, but once running, it will continue to run, maintaining its speed, but operating at an increased temperature and taking greater current from the remaining lines. The single-phase capacity of the motor is about 60 per cent. of its polyphase rating. If the load exceeds this amount, the motor will probably blow the remaining fuses and stop, or if these be too liberal, it may overheat and damage the insulation or even stall and burn out.

Detecting Conditions by Voltmeter and Ammeter

Conditions in the supply system leading to motor trouble may be readily detected by voltmeter or ammeter. A voltmeter placed across the phases successively will indicate either single-phase or unbalanced voltage supply. Ammeters in the supply leads will read unequal in cases of unbalanced voltage, but faults within the motor may also give this indication, so that it is not conclusive.

Overload is one of the most common causes of induction-motor trouble. The pull-out torque of the ordinary induction motor is much higher than the load which it can continuously sustain. There is no com-

mutator to indicate by sparking that the load is excessive, temperature being the only warning symptom. It is not, therefore, an infrequent occurrence for an induction motor to carry an excessive load unnoticed while the insulation becomes charred or the rotor connections loosened. Overload is commonly a fault in application, too small a motor being selected or too much load applied or added. Frequently, however, an unusually heavy load is thrown on a motor by reason of some change in adjustment or operation of the driven machine. Comparatively few machines perform a fixed duty without variation from any cause. A typical instance may be cited. A motor driving a clay-grinding pan operated well for some time, but one day it took excessive current, blew fuses and ran very warm. Investigation showed that the clay was more damp than usual, greatly increasing the power required. Clay taken from the bottom of a pit could not be handled by this machine in wet weather. Induction motors will handle overloads of short duration with ease, but continuous overloading must be watched for and avoided. An occasional ammeter test is a good preventive of trouble.

With wound-rotor motors it is possible for trouble in the secondary circuit to occur outside of the motor. The resistance of the rotor circuit of an induction motor does not, within moderate limits, affect the maximum torque of the motor. It does determine the speed at which maximum torque is exerted. Low resistance in the rotor circuit causes maximum torque to be exerted at nearly synchronous speed, the standstill or starting torque being much less than the pull-out torque. It is thus evident that if it be attempted to start a motor of this type under load, with the external resistance short-circuited, comparatively little starting torque is available and the motor may be unable to pick up.

Effect of Rotor Resistance on Torque

As already stated, low resistance in the rotor circuit causes maximum torque to be exerted at nearly synchronous speed. A higher rotor resistance causes the maximum torque to occur at a lower speed and the starting torque to increase. At a given rotor-circuit resistance the maximum torque occurs at standstill. The motor then has high starting-torque ability with diminishing torque at increasing speeds. If the rotor resistance be still further increased, the maximum torque is actually decreased, although still occurring at standstill. It should thus be evident that any cause of high resistance in the rotor circuit, such as poor joints or contacts or broken grids, will cause the motor to drop in speed under load, and if sufficiently severe, will cut down the pulling ability of the motor, preventing its coming up to speed or starting, under load, at all.

The secondary circuit of a wound-rotor motor is practically always wound three-phase. The external resistors are commonly star-connected. Breakage of a grid will open a phase and leave the secondary circuit single-phase. With one phase of the rotor circuit open, the motor has little starting torque and a decided tendency to remain at half synchronous speed, particularly if accelerating a load. With the motor running, the current in the primary lines will be practically balanced. With the rotor held fixed, the primary current will be unbalanced, the amount depending upon the exact rotor position.

If all the phases in the secondary circuit of a wound-rotor motor are open-circuited, the motor will have no torque and will not start. The primary current will be only the small magnetizing current required to set up the flux in the core.

Cast Iron at High Temperatures

DOES steel grow stronger or weaker with an increase in temperature? How about wrought and cast iron? Although these metals are used more than others in engineering work, few engineers can answer these questions correctly because very little has been written or spoken on the subject. It is an important subject, and yet a search through well-known engineering text-books on the strength of materials reveals their incompleteness as well as the lack of general knowledge of the facts. Tests have been made, mostly in Europe, but the results of those tests have been buried in dry, voluminous reports or in foreign-language literature. These tests have recently been sought and collected by the Vulcan Soot Cleaner Company.

Permanently installed soot cleaners must often be placed in temperatures that are comparatively high. Even laymen are aware that when metal is heated to a

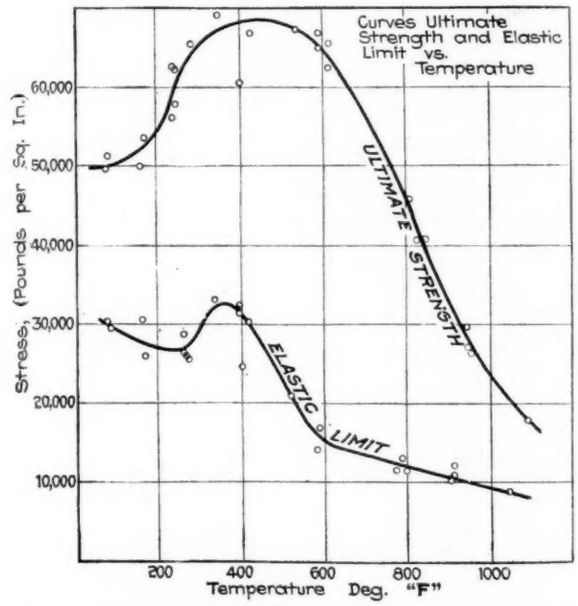


FIG. 1. ULTIMATE STRENGTH AND ELASTIC LIMIT CURVES

high temperature it bends easily, that when it is "red-hot" it is easily forged, and that when still hotter it becomes liquid. But these phenomena are not associated with a decrease in tensile strength, although it is this decrease in tensile strength that permits the metal rod or pipe to be bent or easily broken, and that is why tensile-strength tests are so important in this discussion. On the other hand, it is commonly believed by engineers who have given more thought to the subject that steel and wrought iron become weaker with an increase in temperature. But that is not strictly true, and therein lies a point of considerable interest.

Steel and cast iron both grow stronger up to a certain point as shown by the ultimate-strength curves in Figs. 1 and 2. Thus the maximum strength of wrought

iron occurs at a temperature of 450 deg. F., whereas the corresponding temperature for steel is about 525 deg. F. However, with further increase in temperature the curves show that the ultimate strength decreases rapidly. These curves also give the elastic limits of wrought iron and steel at high temperatures and the curve relation between elastic limit and ultimate strength. Fig. 1 shows that the ultimate strength of wrought iron drops rapidly when the temperature is in the neighborhood of 1000 deg. F., and Fig. 2 shows that at the same temperature, steel no longer has an elastic limit. In other words, if, for instance, soot-cleaner elements are made of steel alone, and if they are heated to a temperature of 1000 deg. F., they are liable to sag owing to their own weight and become inoperative in a short time.

The maximum temperature to which soot-cleaner elements are subjected is not definitely known, but it is doubtful if the temperature of the metal itself ever passes 1000 deg. F. even though the temperature of the hot gases is 1500 deg. For example, a test made by A. W. Conklin shows the temperature at the top of the first pass in a hand-blown boiler to be 954 deg. F. In the same boiler, cleaned by a permanently installed cleaner, the temperature at the same place was reduced to 934 deg. or a difference of 20 deg. in favor of the mechanically cleaned boiler. Thus the mechanical cleaner protects itself in providing for itself a minimum temperature. Even at points close to the fire near the bottom of the first pass, there was a temperature difference which favored the mechanical cleaning method. Although it may sometimes be necessary to place soot-cleaner elements in gases having a temperature of 1500 deg. F., as for instance in the first pass of a water-tube boiler, it has not been found difficult to maintain a temperature in the elements of less than 1000 deg. F., by means of dead-gas pockets, baffle screens, etc. Convection currents are thus warded off and by placing the elements in close proximity with the

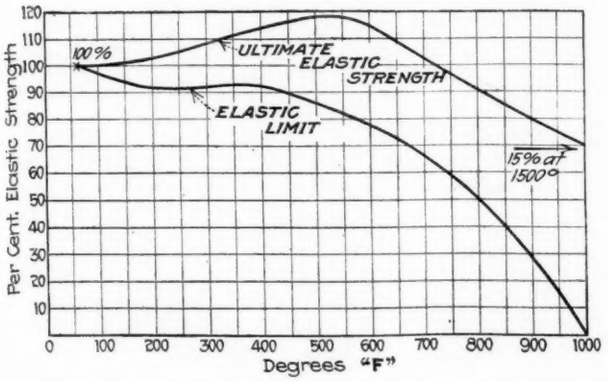


FIG. 2. CURVES SHOWING ULTIMATE STRENGTH IN PER CENT.

boiler tubes, which seldom if ever have a temperature higher than 380 deg. F., the temperature of the element is kept well within the bounds of safety by radiation.

It has been stated by such authorities as Kreisinger and Barkley that in taking temperatures of gases surrounded by colder or hotter surfaces, there is usually an error of 3 to 25 per cent. in temperature. This error is due to radiation. Quoting from "Finding and Stopping Wastes in Modern Boiler Rooms, Vol. II," by the Harrison Safety Boiler Works:

> If a temperature-measuring instrument is immersed in hot gases surrounded by cooler surfaces, it absorbs heat by convection and its temperature rises. Gases are permeable to radiation, and as soon as the temperature of the instrument exceeds that of the surrounding surfaces, heat passes from it to them through the gases by radiation. The temperature of the instrument continues to rise with a decreasing rate until the quantity of heat it gives off by radiation is equal to the quantity it receives by convection. The temperature then remains constant, but is below the temperature of the gases. The magnitude of the error depends mainly on: (1) The size of the part of the instrument exposed to the gases and the radiation; (2) the difference between the temperature of the gases and that of the surrounding surfaces. The smaller the exposed part and the smaller the difference of temperature the smaller the radiation error.

These two rules are applicable to a soot-cleaner element as well as to a thermometer. Thus according

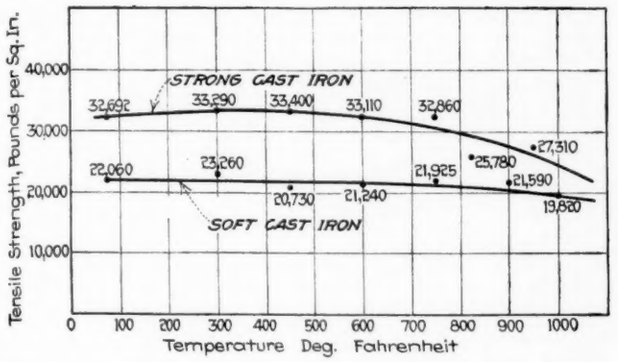


FIG. 3. CURVES SHOWING INCREASED AND DECREASED STRENGTH OF CAST IRON AT DIFFERENT TEMPERATURES

to Rule 1 it is advantageous to make the element large. And according to Rule 2 the difference in temperature (perhaps 600 or 700 deg. F. at times) serves as a further protection.

Fig. 3 is plotted from the test data given in Marks' "Mechanical Engineers' Handbook" for strong and soft cast iron. These curves tend to show that cast iron grows stronger up to a temperature of about 450 deg. F. and from that point on the strength reduces slightly. The strength of soft cast iron, it will be noted, is practically constant all the way from 100 to 1000 deg. F.

From these curves the conclusion may be drawn that cast iron of almost any good composition will protect soot-cleaner elements sufficiently. But for the sake of safety a special tested uniform grade is used.

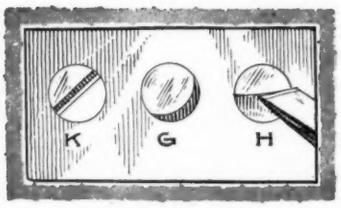
Also, inasmuch as a cast-iron sheath placed over the cleaner element makes the element somewhat larger, it is evident that the rate of radiation will be greater, according to one of the rules quoted. The greater size, therefore, insures lower temperature.

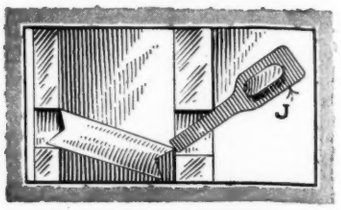
Cast iron also has a high heat radiating factor. Marks' Handbook gives the following factors for the several substances: Cast iron, rough, oxidized, 1570; lampblack, 1540; wrought iron, dull, oxidized, 1540; lime plaster, rough white, 1510; water, 1120; wrought iron, highly polished, 467; brass, dull, 362; copper, slightly polished 278.

In the field of steam engineering, all are familiar with superheaters that have cast-iron rings placed upon the inner tubes of steel, these being used principally to prevent overheating and warping. These superheater rings do not scale or burn.

Cutting Out Stay Bolts

R. E. McNamara





AN UNUSUAL but quick way of removing stay-bolts from a boiler came to my attention some years ago, and as the same principle will apply to other similarly located bolts or studs, the method is at least worthy of consideration.

The illustrations show the method employed in doing the work. It should be noted that the outside, or heavier, plate is the one at which the stay-bolt usually breaks, as shown by the top stay-bolt of Fig. 1. This is because the inner sheet, being thinner, will give somewhat, due to expansion and contraction, and it is this giving and bending with the extreme heat of the firebox sheet that causes leaky stay-bolts that are sometimes found in boilers in operation.

In modern practice stay-bolts are, as a rule, drilled on the outside end and give warning through the telltale hole when they are broken halfway through. Of course a leaky stay-bolt is an indication that renewal is required. In ordinary practice the method of removing stay-bolts is to drill through each end of the bolt at least the depth of the sheet and after removing the burr with a gouge, the bolt can easily drop in the water-leg. Where ratchet or motor drills are to be had, there is no objection to this practice. On an outside or emergency job, however, where hammer tools only are available, the following method will, in the hands of an expert, not only be found a valuable makeshift, but will permit of the removal of stay-bolts faster than they can be drilled.

With a handle chisel or chisel bar, first remove the heads of the bolt, Fig. 1, on both inside and outside sheets *A* as at *B;* then with a flat chisel, a cape chisel or a gouge *M*, remove a half-moon section or a V-section, or even an upper segment of the bolt end on the inside sheet, as shown at the cross-section at *C*, Fig. 2, and in the plan view at *G* and *H* of the headpiece. The purpose of this will be made apparent.

With a hand chisel, preferably on the outside sheet, take a full cut across the face of the center of the stay-bolt, as shown at *K*, keeping the chisel sharp and well-greased and taking successive and deeper cuts until after the third or fourth cut the depth will be about half the thickness of the sheet. Then turn the chisel and point it at an angle to enter between the sheet and the stay-bolt when driven into the water space. Drive the bar in about an inch or two so that when it is withdrawn one can see directly into the water space. Withdraw the chisel and drive it in the same manner into the space on the other side of the stay-bolt, as shown at *D*, Fig. 3, by the dotted line.

The burr remaining in the outside hole may now be broken out without difficulty with a hand gouge *M*. It is then driven into the water space over the top of the bolt, as shown at *E*, Fig. 4. This draws the bolt downward, and if the segment has been fairly removed, as shown at *G*, *H* and *C*, the top of the bolt is prevented from binding and it is readily withdrawn from the hole and dropped into the water space. As the bottom of this end of the bolt tilts upward, the threads at this point are left in good condition.

Should the bolt have a tendency to stick from any cause, the taper gouge *F* may be driven in half its length, and then if hammered sidewise on the head so as to drive the tool around in a circle, the bolt will be worked out of its hole. If no suitable gouge is at hand, a punch bar or handle punch may be placed on the end of the bolt, as shown at *J*, and if driven down with a sledge hammer, the bolt will be forced out of its hole.

It will be readily recognized that the fine point of operation lies in the proper gouging out of the segment from the stay-bolt. The deeper the distance cut the easier the bolt can be pulled from the inner sheet. In fact, it is not at all uncommon for the bolt to pull out when the cape chisel is first driven into the water space, as at *D*.

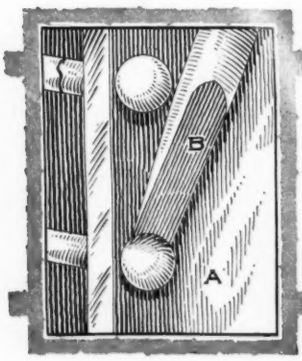


FIG. 1. CUTTING THE STAY-HEAD

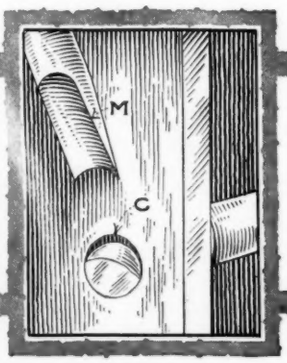


FIG. 2. CUTTING V-SECTION

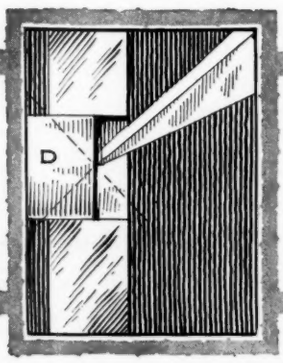


FIG. 3. CUTTING END OF STAY-BOLT

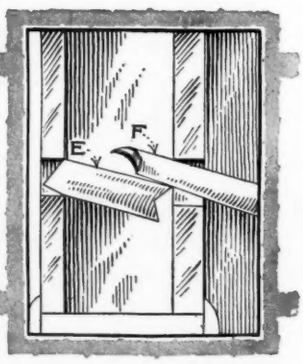


FIG. 4. LOOSENING THE STAY-BOLT

Some Features of Low-Compression Oil Engines—I

By L. H. MORRISON

The author briefly reviews the principles of the two-stroke-cycle type, taking up the various cylinder-head designs with their respective advantages and disadvantages, explains the necessity for water injection and discusses the causes leading to scored cylinders.

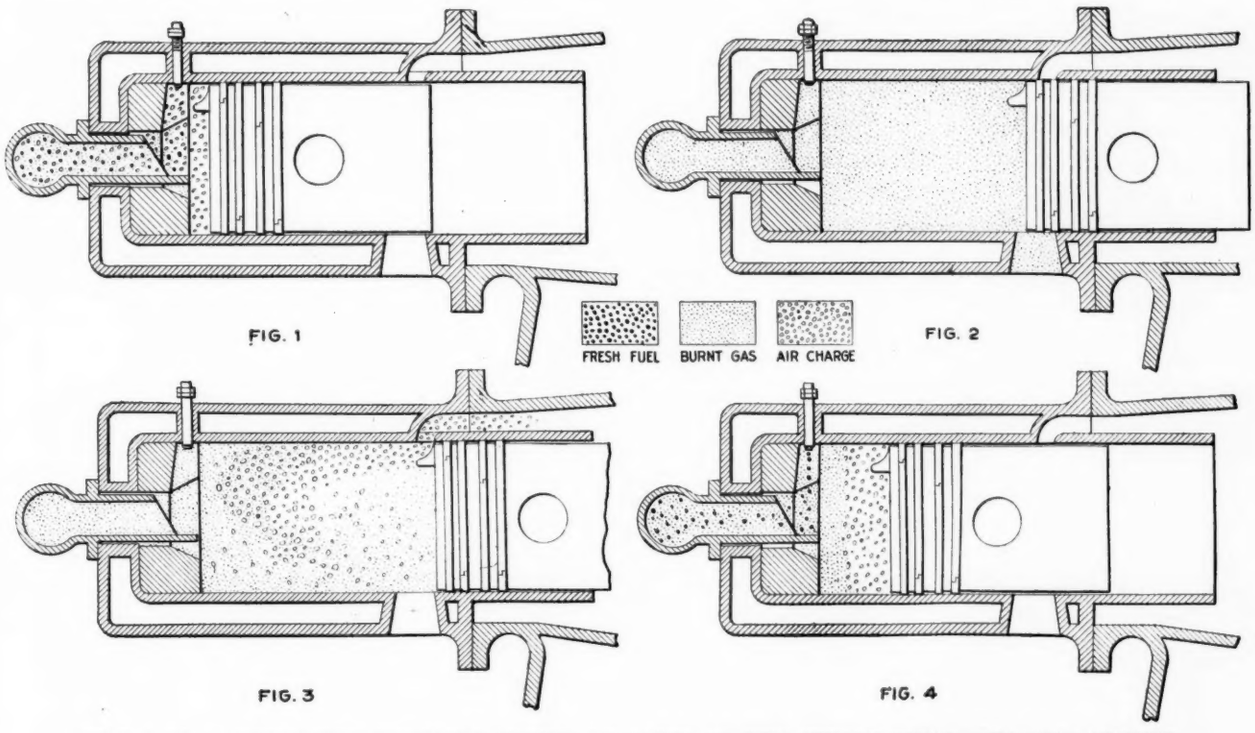
THE crude-oil engines, as built in America, have, by common consent, been divided into three classes, or types: The Diesel, or high-compression; the semi-Diesel, or medium-compression; and the low-compression engines. As separated, the word "semi-Diesel" does convey a distinction as regards the limits of compression carried in the engine. However, of late this term has been sadly misused and in many cases is used in order to make an engine of one type attractive to the public by borrowing part of the name of an entirely different machine. The writer knows of a number of distillate-oil engines that have been given this name, based on the fact that they used oil of a lower gravity than gasoline.

Probably the greatest volume of engine business, both in number and in horsepower, is in the low-pressure type. This design has been built in this country for 15 years or more, and the total number of installations is large. The majority of these units are installed in small mills, factories and light plants, usually where the engineer has but little access to information on the oil engine.

It is for these operators in particular that the writer ventures to outline the design and operation of some of the engines encountered.

The low-compression engines are mostly modifications of the original Hornsby-Akroyd engine, but as many of the present-day engines are of the two-stroke-cycle type, making use of either the front end of the cylinder or the air-tight crank case as the air compressor, this class will be considered.

Figs. 1 to 4 show this type with the crank at different angles. In Fig. 1, after the bulb on the cylinder has been heated, the fuel is sprayed upon the hot lip of the bulb and, on igniting, drives the piston forward. At a point as indicated in Fig. 2 the exhaust port is uncovered by the piston and the burnt gases rush out through the exhaust pipe. Fig. 3 shows the air port uncovered by the piston and the compressed air from the crank case displacing the exhaust gases and filling the cylinder with pure air. In Fig. 4 the piston has compressed this air charge to about 70 lb., and the fuel is beginning to spray into the combustion space.



FIGS. 1 TO 4. INDICATING PROBABLE MIXING OF GASES IN TWO-STROKE-CYCLE HOT-BULB ENGINE

The theory of this engine is based on the fact that the heavier oils will not self-ignite in the presence of air having a temperature corresponding to 90-150 lb. compression pressure, but if this oil strikes a hot surface, it will "crack" and vaporize with consequent combustion. Since the combustion of the oil involves

a process of distillation of the oil into gas before burning, the time necessary for complete combustion is somewhat longer than in the gasoline engine or in the Diesel engine. Consequently, if the speed of the engine is kept above 200 r.p.m., the oil must be injected at such a point before dead-center as to allow it sufficient time to vaporize and burn. The current practice is to begin the injection when the crank is about 30 deg. ahead of rear dead-center, allowing the injection to cease before the piston is at the end of its stroke. Since practically all the oils used contain a percentage of lighter constituents that will vaporize and burn at a low temperature, there is a tendency of this part of the oil to ignite before the piston reaches dead-center and while the compression pressure is still low. To avoid this, builders depend upon one of two factors—they either design the combustion chamber so as to allow the fresh gases to remain unmixed with the fresh air until the piston is about 10 deg. from dead-center, or they provide for the injection of a small quantity of water at each cycle; this water tends to keep down the temperature in the cylinder so as to preclude the preignition of the lighter parts. Stratification of the gases and air as aimed at in the first method does occur in some of the designs, although it is far from successful in all.

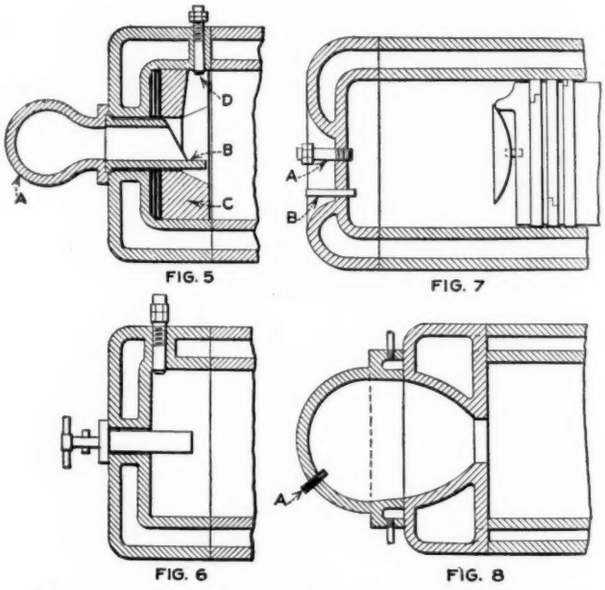
Some Types of Ignition Devices

Fig. 5 shows a cross-section of the ignition device used on one engine long on the market. In this the cylinder head is a plain water-cooled casting of a design free from danger of heat fracture. To this head is bolted the bulb *A* projecting outward, and against this bulb is placed a "spoon," or lip, *B*, which passes through an opening in the head and projects into the cylinder. There is also a heavy block or combustion chamber *C* fitting into the cylinder space. In starting, the bulb is first heated to a high temperature (not red heat) by a torch. As soon as the engine is started, either by cranking or by using an air starter, the fuel pump injects a charge of oil through the nozzle *D* immediately above the hot spoon. This oil, on striking the spoon, is "cracked" and vaporized, and mixing with the air charge, is ignited by the hot bulb.

Since this engine operates on the two-stroke cycle, the air charge, as it blows through the air port, is unable to completely scavenge the cylinder of all the burnt gases. Especially is this true as regards the bulb. The bulb, being fitted with a small opening into the cylinder, offers no opportunity for air-scavenging; as a result, it is charged with burnt and inert gases even after the exhaust period. Consequently, when the fuel is vaporized by the hot spoon, the movement of the air charge in front of the advancing piston pushes this vapor into the bulb where it mixes with the inert gases. As there is no free oxygen present in this bulb, there can be no explosion, although the temperature, due to the hot bulb and to the compression pressure, is much above the ignition point.

As the piston advances toward the head, the air is forced into the bulb, where it mixes with the oil vapors and burns. This stratification of the oil vapors, the burnt gases and air is fairly successful at loads up to about three-quarters of the engine rating. At values approaching full load, the beginning of the injection of oil is much advanced, and the amount of fuel injected is increased to such a value that the bulb does not accommodate all the vapors. As a result, part of the fuel charge mixes with the pure air in the cylinder. As the temperature existing in the cylinder, due to the hot bulb and to the compression, is above the ignition point, preignition of the charge frequently takes place, resulting in piston pounding and loss of power. In order to avoid the preignition this engine, as do most others, makes use of water injection, whereby at each cycle a small quantity of water is injected into the cylinder, reducing the compression pressure and the temperature existing in the cylinder. Due to the stratification of the gases on loads below three-quarters rating, it is not necessary to use the water at lower values.

The combustion block *C* merely serves as a reservoir of heat. When using kerosene or the lighter distillates, this block gives off enough heat to vaporize the oil before it strikes the spoon; with heavy fuels below 30 deg. Baumé test, most of the charge actually strikes the spoon before vaporizing.



FIGS. 5 TO 8. SHOWING TYPES OF IGNITION DEVICES

Oils of different gravities will ignite at different temperatures and at different pressures. In order to make the time of ignition constant, it is necessary to vary the compression pressure according to the character of the oil used. To do this, some builders have resorted to placing compression plates behind the combustion block. By varying the number of plates used, it is possible to secure from 90 to 140 lb. compression; the former suitable for kerosene, the latter for heavy oils down to 24 deg. fuel oil.

The hot bulb has a number of advantages. Among these is the fact that, being made with fairly thin walls, the bulb will break in case of any dangerous increase of pressure in the cylinder, thereby protecting the more expensive parts, such as the cylinder and the cylinder head. It has the advantage of low replacement cost in case it is burned out or fractured, but the disadvantage of tending to fill with unburnt carbon in cases of leaky fuel-injection nozzle, too low compression

or too low a temperature of the bulb. This tends to lower the power of the engine, and the carbon is hard to remove on account of the shape of the bulb.

A second device is that shown in Fig. 6. Here the head is completely water-cooled and has a tube projecting into the cylinder space. This tube may be fixed or removable. If fixed in place, part of it extends beyond the outside wall of the head and is heated by a torch. In the drawing shown, the tube is removable and is first heated by the operator at any convenient fire and is then placed in its recess and clamped into place. The engine is started, and the fuel is injected in a manner similar to that of the hot-bulb engine. The oil, on leaving the nozzle, strikes this red-hot tube and of course vaporizes. This vapor mixes with the air charge, and as soon as the advancing piston has raised the compression temperature high enough, the charge is fired and burns.

In a hot-tube design the scavenging air frees the cylinder from almost all the burnt gases, since there is no pocket or bulb. Therefore the opportunity for stratification of the vaporized oil and air is not so good,

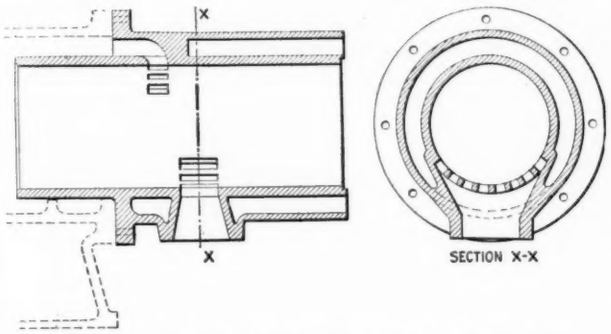


FIG. 9. SHOWING ARRANGEMENT OF INLET AND EXHAUST PORTS

and they doubtless mix immediately. The only way, then, to prevent preignition of the charge is to keep the temperature down until the piston is practically on center. Recourse is had to the use of injection water even at fairly low loads.

With this hot-tube arrangement it is the general experience that this type will operate better on lighter oils than on the heavier fuel oils—quite the opposite of the hot-bulb design in this respect. The hot-tube engine scavenges better than the hot-bulb and consequently shows a slightly superior economy at the heavy loads since the cylinder is charged with practically pure air, insuring a better combustion. The tube is simple, easily replaced if defective, and the design allows the head to be made symmetrical and free from casting strains. On the other hand, it does not present a large surface to the injected oil and often does not give off enough heat to vaporize all the charge when using heavy fuel oils.

Some engine builders have adopted modifications of the hot-plate design, as in Fig. 7. In this design a bell-shaped iron casting is bolted to the piston head. To start the engine the cylinder head is provided with a small hot tube, which is heated by a torch. The fuel is injected through the nozzle *A*, which is located in the center of the cylinder head. On starting, this oil will drip down onto the starting tube *B* and ignite. After a few revolutions the bell casting or hot plate attains sufficient temperature to allow the torch to be removed.

In this design the cylinder is practically free from obstructions, and the scavenging effect of the air charge is good. On the compression stroke the air charge is compressed to 120 to 140 lb., and at about 20 deg. from dead-center the fuel is injected through the nozzle. The hot plate remains at a high temperature, due to the heat absorbed from the burning fuel. Using light distillate, the temperature existing in the cylinder is sufficient to vaporize it before any strikes the hot plate. There is but little stratification of the cylinder contents, and where the fuel used contains very light constituents, there is a tendency to preignite at all loads. This is especially noticeable on heavy loads when the injection begins earlier in the stroke. As a result, it is necessary to use water injection.

Some Good Points of Hot-Plate Design

The hot-plate design is good in many respects. It is better than the hot-tube when using heavy fuels, as it provides more vaporizing and igniting surface. It is not liable to become overheated or burned, as it has an opportunity to give off part of the excess heat to the exhaust. Furthermore, as the air enters the cylinder, it blows across this plate, cooling it to a considerable extent. This is an advantage at full load, but on the lighter loads this cooling effect quite often results in the plate not igniting the fuel charge. It is doubtful if the hot plate helps the lubrication; certainly, many operators are in constant fear of faulty lubrication due to the high temperature of this plate burning the lubricating oil off the cylinder walls on the compression stroke.

To attain fair stratification with consequent avoidance of water injection, the ignition device shown in Fig. 8 has been brought out. With this construction a cavity is cast in the head, having a small opening into the cylinder. To make a complete combustion chamber a semi-spherical casting is held against the cavity by means of a retaining collar. The cylinder head is completely water-cooled, consequently the half of the combustion chamber formed in the head is also water-cooled; the combustion chamber cover or cap is partly water-cooled. The oil is usually sprayed in at the side of the chamber.

To start this engine, the starting tube *A* is first heated by the torch, and the flywheel is turned over on compression. The fuel is injected through the nozzle, and on striking the starting tube ignites. After a few minutes' run the cap absorbs sufficient heat to vaporize the oil, and the torch is removed.

The scavenging air frees the cylinder of practically all the burnt gases. Owing to the restricted opening into the combustion chamber, it remains filled with the inert gas during the compression stroke. The fuel is injected directly into the combustion chamber, when the piston is 20 to 30 deg. from dead-center and the temperature of the chamber cap is sufficient to vaporize it. When the piston approaches the head, the air is forced into the chamber and, uniting with the oil vapors, causes combustion. The piston leaves but a slight clearance in the cylinder, and all the combustion occurs in the combustion chamber; the hot gases passing through the narrow opening act on the piston face.

This design is an excellent one. The fuel being burned outside of the cylinder, there is no danger of unburnt carbon deposits cutting the cylinder wall. As a result the amount of lubrication necessary is considerably less than in the case of a hot-tube or hot-plate engine. Since the combustion chamber is filled with burnt gases when the fresh oil charge is injected, there can be no ignition until the piston forces the fresh air into the chamber. Having the advantage of being partly water-cooled, the combustion chamber does not become overheated. However, on full loads, the amount of heat absorbed by the walls is so considerable as to cause the cap to get cherry red. To reduce this temperature the cap, as already mentioned, has a small cooling space, and the operator must open the cooling-water connection to this cap. This sudden chilling quite often causes the cap to break; in fact, this is the one very serious drawback to this design of combustion chamber.

As there is good stratification of the gases, the builders have eliminated the water-injection feature. Without the water injection the engine operates on the partial loads, up to about 80 per cent. of normal rating, without preignition; at full load the amount of the oil charge is great enough to allow some of it to escape into the cylinder, resulting in preignition. This, of course, applies to cases where the fuel used is of high gravity, as in this case the compression pressure is sufficient to cause preignition, being about 160 lb. This type of engine operates best on distillates above 32 deg. The temperature of the combustion chamber is not sufficient to completely vaporize the heavier oils, such as 24-deg. fuel oil. Consequently, using this heavy oil, there is always a heavy deposit of carbon in the chamber, demanding frequent cleaning. The fuel economy, compared with other low-pressure engines, is good. This is due, in part, to the fact that in this engine there is not the thermal loss which occurs with water injection.

Modified Design Used on Vertical Engines

A modification of this design is used on vertical engines. In this construction the entire combustion chamber is water-cooled with the exception of a flat cover plate. By this means there is no overheating of the chamber at full loads, as the water cooling keeps the temperature from getting too great; in fact, on partial loads the cooling is too successful, resulting in some of the fuel charges not igniting at all. This is especially noticeable when using heavy fuel oils. As a result, if the engine runs on partial loads very much of the time, there is a decided tendency toward heavy carbon deposits both on the combustion-chamber walls and on the flat cover plate.

Since the combustion chamber is cooled by the same water that flows around the cylinder walls, there is no means of varying the cooling effect. Undoubtedly the engine would operate better if the combustion jacket were cooled independently of the cylinder.

The casting is rather complicated, and as a result there are severe shrinkage stresses existing in the head; these strains, augmented by the explosion stresses, frequently cause fractures.

From the foregoing it is apparent that there are a number of different cylinder-head designs. Indeed, one cannot find any two builders whose engines' heads correspond very closely. On the other hand, the various builders follow two general designs in cylinder construction.

Fig. 9 is a typical cylinder where crank-case compression is used. This consists of a simple casting with the necessary cored passages for the exhaust ports, air intake, etc. This design is closely followed by a number of builders. The details upon which they differ are usually the shape and extent of the air ports, and the position of the exhaust ports.

To attain a good scavenging effect with the air charge, it is necessary that the air be properly directed. It is good practice to have the air passages enter the cylinder at an angle so as to direct the air toward the cylinder head, and one need not rely exclusively on the deflection plate on the piston. It is about as harmful to have too much air-port area as too little. Some builders attempt to place the ports as far around the cylinder girth as the exhaust passage permits—thinking in this way to obtain a better scavenging effect. However, as the air enters the many ports, it tends to focus on the center of the cylinder head, resulting in eddy currents that do but little good. Furthermore, with a decreased port area the air velocity is higher with a consequent better cleaning of the cylinder.

Piston Should Uncover Exhaust Ports First

It is best to have the air ports so located as to allow the piston to uncover the exhaust ports first; in this way a greater part of the gases pass out of the cylinder before the air enters. This decreases the amount of air required. At the same time it allows the air pressure to be less, since the gases in the cylinder would be at practically atmospheric pressure. In many installations the exhaust falls below atmospheric pressure owing to the inertia of the column of exhaust gases forming a vacuum at the engine. The various builders follow a general rule of having the exhaust ports cover from 15 to 20 per cent. of the engine stroke, dependent upon the size of the unit.

In both of these designs it is well for the operator or purchaser to see that the cylinder walls are thick enough to allow for at least one reboring. The walls should be calculated from the formula for a cylinder with thin walls,

$$t = \frac{pD}{2S} + k$$

where

t = Thickness of cylinder walls;
p = Maximum explosion pressure;
D = Diameter of cylinder;
S = Allowable fiber stress;
k = Constant to allow for reboring, its value depending on cylinder diameter.

Diameter Cylinder	6 to 11 In.	12 to 20 In.
Value of k	$\frac{1}{16}$ in.	$\frac{1}{4}$ in.

It is common practice with low-pressure engines to cast the cylinder liners integral with the jacket. This undoubtedly is the most satisfactory to the operator. It is very easy to provide material for reboring and at the same time keep the thickness down to a value where the cooling effect of the circulating water is sufficient. It is seldom that the cylinder liner develops a fracture, and so the replacement cost may be forgotten. As regards the reboring feature, a few builders are follow-

ing the practice of selling a new piston, oversize, and a rebored cylinder to the engine owner, taking as part payment the worn cylinder; this cylinder is then rebored at the factory and sold to the next customer.

Practically all these low-pressure engines have approximately the same compression and mean effective pressures. It is surprising to note the divergence of opinion in regard to necessary cylinder volumes to develop a given horsepower. The fact that one engine has a larger volume swept out by the piston should indicate that it has a greater overload capacity and at the same time not quite so good a fuel economy at the rated load as would be shown by an engine with a smaller volume.

Scoring and Cutting of Cylinders

The question of cylinder wear on the low-pressure engine is very vital. Probably this point is raised more often than any other where such an engine is being considered. Looking back into the history of the development of this type, one must concede that cut and scored cylinders figure quite prominently. A number of things were contributory causes. Water injection was blamed by many; lack of lubrication, poor grade of cast iron, and lack of cooling effect by others. Water injection may have some effect where kerosene is used or where the fuel oil is high in sulphur, but for the fuel or distillate oils ordinarily used, it is open to dispute as to whether the water does cause cutting. A great number have run from five to seven years without any decided cutting. Possibly the chief cause of this cutting is due to lack of proper lubrication of the piston and cylinder. It is a common occurrence to discover an operator using a light gas engine or automobile oil, and these oils do not have sufficient body to lubricate an oil engine properly. Many use an oil that has not been filtered properly and which tends to carbonize. The result usually is a deposit of carbon on the piston that speedily scores the cylinder.

Many instances of scored cylinders can be attributed to the faulty design of cylinder and piston. The temperature of the exhaust gases is high, and as they pass through the exhaust ports, they raise the temperature of the exhaust-port bridges to at least 800 deg. There is, at best, but a poor cooling effect around the exhaust ports, and often this high temperature causes the bridges to elongate and to bend. This, of course, will score the piston on the under side. In some engines the piston is made as light as in a gas engine. The head and walls being very light, they do not have enough strength to resist any distorting stress that might arise, such as that due to the top of the piston being cooler than the bottom. Once the piston gets out of round, it is only a question of a short time until the cylinder is cut.

The Strength of Winding Drums

By John S. Watts

I have been unable to obtain data regarding the mathematics required for calculating the ultimate or the safe strength of the shell of a drum to carry more than one coil of rope, such as the drum of a hoisting or of a winding engine.

I therefore evolved the following method and have used it for some years without any failures. I have known of drums that have collapsed which my method of calculation figured to be unsafe; this would seem to prove its correctness. However, I made some assumptions that are not provable, and I would welcome confirmation from the experience of other engineers, as it is possible I am working too far on the safe side. I use the following symbols in my reasoning:

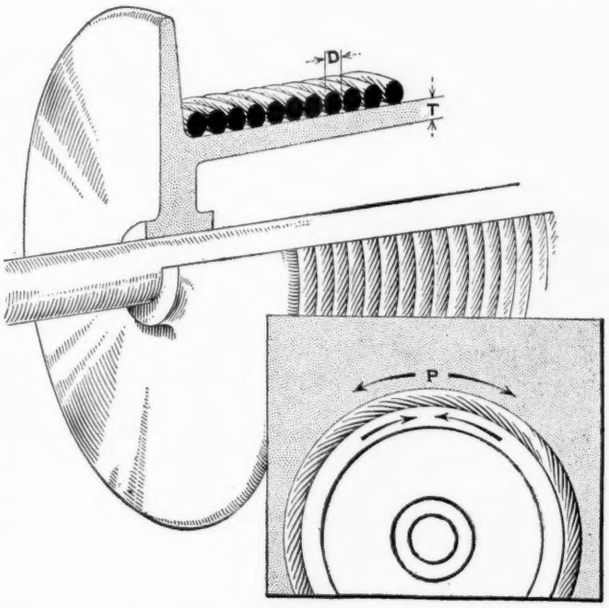
P_1; P_2; P_3, *etc.* = Pull on the rope in pounds, in the first, second and third coils;

S = Allowable stress per square inch of the material in the shell of the drum;

T = Thickness of drum shell in inches;

D = Diameter of rope in inches.

The load put on the drum by the first coil of rope is not in doubt as (referring to the illustration) it is obvious that the tension P, or pull on the rope, is



ILLUSTRATING DRUM AND FIRST COIL OF ROPE, ALSO DIRECTION OF PULL OF THE ROPE

resisted by a compressive strain on the drum shell equal to P_1; and assuming the rope to be close-coiled as shown, the area of material in the drum carrying this compression is equal to $D \times T$. Therefore the stress placed on the drum per square inch is

$$S = \frac{P}{D \times T}$$

or to find the required thickness, the formula is transposed and becomes

$$T = \frac{P}{D \times S}$$

Where there is more than one coil, I use the formula,

$$T = \frac{P_1 + P_2 + P_3 \text{ etc.}}{D \times S}$$

The assumption is that each coil adds its pull to that already placed on the drum by the previous coils. It should be noted that the pull on the rope will very seldom be the same for all coils; for example, in hoisting, the pull becomes less with each coil, as the weight of rope hanging becomes less as the rope is wound in. Also, in winding we have a similar effect, and further,

the pull due to acceleration of the load comes only on the first coil.

To be on the safe side, I take the maximum pull on each coil, although it may be that that part of the rope having the maximum pull in any one coil does not come when wound on the drum directly over the part of the preceding coil having the maximum pull in its coil. This is because one can never be sure just how a rope will coil on a drum after the first two or three coils are on. There may be cases, though, where this point would be worth taking into account.

Against the assumption made, we have the argument that the inner coils carry a part of the compressive load due to the outer coils, and while probably they do to some small amount, the proportion of the total load thus carried by the coils of rope cannot, in my opinion, be very great and is too doubtful a quantity to be safely calculated on, even if we knew how to calculate it.

As the load is gradually applied and cannot exceed the amount calculated, I use a factor of safety of 3, taking cast iron as having an ultimate compressive strength of 90,000 lb., thus giving the safe stress, or $S = 30{,}000$ lb.

The Superintendent and the Engineer

By Lee Prior

MUCH has been said about the different departments of a plant working in harmony, as well as the earnest coöperation of the individual workmen, but it is apparent that in order that men may have the best understanding of the work at hand, they must be taken somewhat into the confidence of the management. Here is where the "fine work" of the superintendent comes in, and he should direct the whole work with the least possible friction. Men who have made a study of human nature understand this, and without doing anything to lower their dignity, give orders in a proper manner.

These orders are usually executed with pride, prudence and precision, for the engineer feels that he is recognized, consequently he will do his best to show his appreciation of the confidence placed in him. To the untrained mind this seems a small matter, but in many cases it means all the difference between contentment and dissatisfaction, or success and failure. In some small plants the superintendent feels at liberty to go into the engine room and shut down the engine whenever there is an excuse for doing so, feeling that he has the right to do this by virtue of his office; but he never should do it except in cases of urgent need and when the engineer is not in the engine room. The engineer, hearing the engine change its tune, comes in hastily to see what caused the change and is intensely disgusted to find the superintendent at the throttle; but if he remonstrates, it is almost sure to cause hard feeling.

In one case the engineer requested the superintendent to simply give him the necessary orders on such occasions, but his request was ignored. One day he saw the superintendent going toward the throttle and hastily started for the same objective point. One can readily imagine the details of this intensely interesting scene, but for some reason the superintendent stopped short and the engineer also stopped long enough to give him an "eloquent look," then proceeded to shut down the engine. He was not troubled further along this line.

In some instances a superintendent has been known to make changes on the engine at night, either telling the engineer about it the next morning or not according to his frame of mind. This is an effective way to prevent the engineer from taking that lively interest in his plant without which he never gives the best possible service to his employers. He may do enough to prevent a shutdown, but the difference between such service and the full measure given by a really interested engineer is much greater than the average superintendent or employer suspects.

Another case is related where a certain engineer was in charge of an old-fashioned boiler that was well-covered by brickwork, which prevented a thorough examination. It was heavily loaded, making it necessary to carry high pressure. The engineer told the boiler inspector that he feared it was not safe, and together they referred the matter to the superintendent for permission to remove some of the bricks and make a thorough examination. To the great surprise of both, he flew into a towering rage and made many unwise statements.

The inspector was told to remove the insurance if he wanted to, and the engineer was ordered to run the boiler as he found it or get off the premises. As neither the inspector nor the engineer really knew that the boiler was defective, they quietly told him so, and as they were men of sound judgment they ended the incident; but the engineer proceeded to remove some of the bricks until he saw enough of the shell to warrant the conclusion that it was still sound. This result was never reported to the superintendent as it was not necessary, but if defects had been discovered the true condition of the boiler would not have been concealed. If the risk had been only a financial one, it would not be worth mentioning, but taking chances on boiler explosions is an entirely different thing.

In another case the engineer was in doubt about the condition of a boiler and asked to have it inspected, but his request was refused. He took the liberty to invite the inspector to come and make an examination, but the superintendent refused to allow it and discharged the engineer. In both of the cases cited the boilers were safely operated for a few years until replaced with new ones—the engineers were mistaken, but inspections would have shown this without detriment to anyone. Both superintendents were determined to use the boilers until a convenient time arrived for removing them and no harm came, but others have been less fortunate under similar circumstances.

When the engineer considers a boiler unsafe and the owner or superintendent declines to have repairs made, the engineer is in a tight place; for if he was sure it would explode with the regular pressure, his duty would be plain, but he has no positive proof, hence can only express doubts as to its safety. But to be on the safe side no superintendent should disregard the opinion of his engineer.

Friction and the Coal Pile

By E. S. Morrison

THE average engineer will not forget last winter's coal troubles, and the prospect for the coming winter is far from reassuring. Although the coal-producing states may not suffer industrially, many localities undoubtedly will be embarrassed in their attempts to keep mills and factories in operation. Probably the chief sufferer will be the non-coal-producing South, with its thousands of cotton gins and oil mills.

It is unfortunate that the attempt to solve the coal question is based on erroneous premises. It seems to be the unanimous opinion of engineers that, in order to save coal, we must install more economical power-producing equipment, continual stress being laid on stokers, better boilers and more economical engines. All this without question will decrease the coal consumption but a far greater opportunity to accomplish the same purpose is quite generally ignored. Investigation will disclose that in the average mill plant the friction loss in lineshafts and machinery is a large percentage of the power requirements. Furthermore, a close check usually will reveal that a considerable part of this loss can be obviated.

As an example, some time ago an investigation was made on the power consumption of a 100-ton cotton-oil mill. This mill had been sold to a concern owning an electric-power plant. The new owners scrapped the old power plant and proceeded to electrify the mill, installing a small boiler for the cooking demands.

All appreciated that a one-motor drive was not the most economical, and consequently the various machines were arranged for group drive.

The first month's reading of the meters startled the owners by the enormity of the power used. Various tests were made on the groups, both idle and loaded. The accompanying tabulation shows the friction losses. This table shows the enormous losses that occur in belting, conveyors, bearings, etc. When one contemplates this state of affairs, existing twenty-four hours a day for about two hundred days a year, it is easy to understand the feelings of the board of directors.

Using a few figures to make this loss show in tons of coal, and in dollars as well, we have 141.7 kw. loss per hour. This figures 3400 kw.-hr. per day or 680,000 kw.-hr. per year of 200 operating days. The usual run of power plants of moderate size will burn around 7 lb. of coal per kilowatt-hour. If this value be used, the frictional loss entailed a yearly coal consumption of 2380 tons, which at $3.50 per ton cost the mill $8330.

If rearrangement and redesign of oil-mill machinery could save even 20 per cent. of this loss, each mill would reduce its coal requirements 476 tons. Multiply this by a hundred mills, and the saving reaches the startling total of almost 50,000 tons.

In this particular mill the frictional load could be considerably reduced by realigning lineshafts and equipping both lineshaft and machinery with roller or ball bearings. A still greater saving could be effected if the screw type of seed conveyor were abandoned in favor of some kind of belt conveyor. In fact, the present design of oil-mill equipment must give way to more modern designs.

There is still ample time for the oil-mill managers to go over their plants and prepare to do their part toward the solving of next winter's coal problem.

POWER REQUIREMENTS OF COTTONSEED-OIL MILL

	Idle, Kw.	Loaded, Kw.
Group 1:		
Six linters	14.00	.....
Conveyors	12.00	.....
Lineshafts	9.25	.....
	35.25	52.00
Group 2:		
Seven linters	27.00	.....
Lineshafts	6.00	.....
Conveyors	1.50	.....
	34.50	53.25
Group 3:		
Lineshafts	4.20	.....
Pumps	1.50	.....
Four beaters	5.00	.....
	10.70	19.25
Group 4:		
Lineshafts	8.00	.....
Hullers, shakers, etc	9.00	.....
Beaters and elevators	5.25	.....
	22.25	25.00
Group 5:		
Rolls	14.00	30.00
Group 6:		
Cleaning machinery	16.00	18.00
Group 7:		
Wagon and car elevators and conveyors	9.00	23.25
Total power consumed, kw.-hr	141.70	220.75

The Heating of Substations

By R. von Fabrice

Chief Draftsman, Public Service Electric Co., Newark, N. J.

THE problems involved in designing and installing properly proportioned heating systems for substations do not seem to be generally known when judged by actual installations.

Very few substations have the heating surface properly proportioned to meet the existing requirements involved. Generally, the heat from the apparatus has been neglected, when the heat available from this source amounts to a large percentage of the total required for the building. Transformers, regulators, rotary converters and motor-generator sets all give off large quantities of heat due to inherent losses, therefore proper consideration should be given to this factor when designing the heating system.

When making calculations to ascertain the heat losses of the apparatus, the period of operation of each machine must be taken into consideration in order to properly proportion the heating system to be installed, because if the heat losses are assumed to be constant throughout the 24-hour day for all apparatus, serious errors can be made, as a large portion of the machinery is idle at certain parts of the day and the heating system must be adequate to supply the necessary heat units for the off-load periods.

To illustrate the foregoing, assume a substation containing the five 3000-kw. air-blast transformers, two 1500-kw. motor-generator sets, two 1000-kw. rotaries with air-blast transformers and thirty feeder regulators. Assume operation or service as follows: The heat losses in 20 regulators in service from 7.30 a.m. to 5.30 p.m., 1 kw. each; 10 regulators in 24-hour service, 1 kw. each; 1 motor-generator set doing 24-hour service, the heat losses of which amount to 150 kw.; 1 motor-generator set in operation from 7 a.m. to 6 p.m., with 150-kw. heat losses; one 1000-kw. rotary

converter and transformer in operation from 5.30 a.m. to 9 p. m., the heat losses of which amount to 80 kw.; 1 rotary converter and transformer spare; two 3000-kw. air-blast transformers in use from 7 a.m. to 5.30 p.m., having 40-kw. losses each; two 3000-kw. air-blast transformers in 24-hour service also having 40 kw. losses, and one 3000-kw. air-blast transformer spare.

From the foregoing the maximum heat losses are:

30 regulators; 1-kw. loss each	30 kw.
2 motor-generator sets; 150-kw. loss each	300 kw.
1 rotary; 80-kw. loss	80 kw.
4 3000-kw. transformers; 40-kw. loss each	160 kw.
Maximum total heat losses	570 kw.

Minimum heat losses are:

10 regulators; 1-kw. losses each	10 kw.
1 motor-generator set; 150-kw. losses	150 kw.
2 transformers; 40-kw. losses each	80 kw.
Minimum total heat losses	240 kw.

From the foregoing it is evident that the heat losses of the apparatus are not constant, but vary from 570 kw. maximum to 240 kw. minimum, therefore the heat units per hour available for heating the building due to the losses of the apparatus are: For maximum conditions $570 \times 3413 = 1{,}945{,}410$ B.t.u., and for minimum conditions $240 \times 3413 = 819{,}120$ B.t.u., where 3413 is the number of B.t.u. per kilowatt-hour. Only the minimum heat available from the apparatus can be depended on for heating the building, which in this case is 819,120 B.t.u.

The dimensions of the building are: Inside width, 65 ft., inside length, 90 ft.; height to bottom of roof truss, 45 ft.; monitor full length of building, 6-ft. sides by 12 ft. wide; roof slab, 6 in.; concrete walls, 16 in. thick for 20 ft. high, above this 12 in. thick, brick.

For the building the following areas are obtained: Windows, 1276 sq.ft.; 16-in. wall, 6254 sq. ft., 12-in. wall, 7300 sq.ft.; doors, 160 sq.ft.; monitor, 2250 sq.ft.; roof, 5220 sq.ft., and the cubical contents, 298,350 cu.ft., approximately.

Assuming outside temperature 0 deg. F., inside temperature 65 deg. F., two and one-half changes of air per hour, and 1 B.t.u. required to raise approximately 55 cu.ft. of air 1 deg. F., then the heat losses per hour are as follows:

		B.T.U. per Hour
From windows	$1{,}276 \times 1.1 \times 65 =$	91,234
From doors	$160 \times 0.414 \times 65 =$	4,305
From 16-in. wall	$6{,}254 \times 0.258 \times 65 =$	104,879
From 12-in. wall	$7{,}300 \times 0.315 \times 65 =$	149,467
From monitor	$2{,}250 \times 1.03 \times 65 =$	150,637
From roof	$5{,}220 \times 0.6 \times 65 =$	203,580
From changes of air per hour	$\frac{298{,}350 \times 2\frac{1}{2} \times 65}{55} =$	881,489
Total		1,585,591

The second value, 1.1, 0.414, etc., in each one of the foregoing computations is the coefficient of heat transmission in buildings; that is, the B.t.u. per hour per square foot per degree F. difference in temperature.

Assume the steam in the radiators to be at a temperature of 225 deg. F. and the room temperature to be 65 deg. F., which gives a temperature difference of $225 - 65 = 160$ deg. F.

Two-column radiators 32 in. high will give a radiation per hour for a temperature difference of 160 deg. F. between circulating medium and surrounding air of approximately 280 B.t.u. per square foot of radiation surface.

The maximum heating units required to heat the building without the heat losses of the equipment are 1,585,591 B.t.u., and the minimum heat loss of apparatus is 819,120 B.t.u., therefore the number of heat units required to bring temperature of building up to 65 deg. F. at the lowest period of station load is $1{,}585{,}591 - 819{,}120 = 766{,}471$ B.t.u., and the square feet of radiation is $\frac{766{,}471}{280} = 2737$ approximately; whereas, if the heat losses of the apparatus were ignored, $\frac{1{,}585{,}591}{280} = 5663$ sq.ft. of radiation approximately would be required.

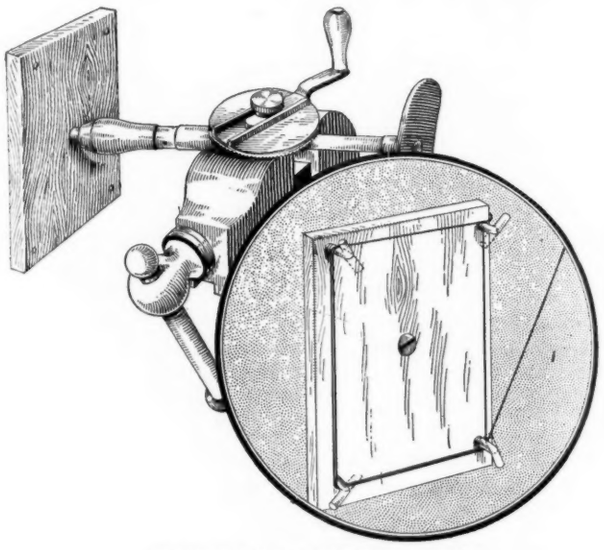
The apparatus supplies $\frac{819{,}120 \times 100}{1{,}595{,}587} = 51.7$ per cent. of the total heat requirements during the period of minimum load.

Making Coils for Small Windings

BY MAURICE CLEMENT

The illustration shows an easy way to make coils, especially for the amateur who has no coil-winding machine in his home workshop. The rig consists of a flat piece of wood about ¾ in. thick on which is plotted out the shape of coil, with right-angle screw-hooks at all angle points, pointing away from the center of the form.

Mark out the center and then run a screw through as far as it will go and clamp it in a breast drill, as shown. Put the breast drill in a vise in a horizontal position with the coil form toward the left, taking care to place it so as to allow free movement of the handle. Take a turn with the wire on a nail on the back of coil form, lead the wire over the edge to the face of the form and turn the handle to cause the form to revolve at any desired rate of speed and the wire to run over all screw-hooks. Keep sufficient tension on the wire to permit the turns to lie snugly. When the specified number of turns has been wound, twist a short piece of wire around each end of the coil to hold it in shape. To remove the coil, turn all screw-hooks, as shown by the dotted lines, toward the center of the form and slip the coil off.



HANDY COIL-WINDING FORM

EDITORIALS

An Example of Self-Hypnotism

THOUGH we may disregard the experiments and conclusions of psychologic investigators, we cannot ignore the evidences of self-hypnotism among certain groups of engineers. Partisans of the central station are undoubtedly affected. They have preached the doctrine of central-station supremacy over isolated-plant operation in season and out, until they have actually hypnotized themselves into believing their own statements.

At the convention of the National Electric Light Association last month, the retiring president, J. W. Lieb, who is also vice president of the New York Edison Company, delivered an address in which he said:

> Much has been said and written recently of the possibilities of joint operation between central-station systems and isolated or private plants operating within the same territory. It does not need demonstration that the coal consumption in the isolated plants is generally from two and a half to four or five times the amount of coal required to produce the same quantity of electrical energy in the central station. The private plant usually requires more or less steam for heating or for the operation of auxiliaries, which may be obtained wholly or in part from the live steam of the boilers supplementing or taking the place of the exhaust steam. These figures would in such cases be somewhat dependent in their relative values on the conditions presented by each individual case; but the fact remains that on the whole there would be a notable coal saving in the operation of all the requirements throughout the territory for light and power from the central electric station with local steam heating for individual cases where it cannot be obtained from a central heating system.

In this pronouncement we recognize the old, familiar slogan of the central station, which has so impressed those who think only in terms of kilowatt-hours per pound of coal. This reiteration was to have been expected, for no advocate of the central station ever makes a public address without dragging in this useful but threadbare argument.

The unusual and unexpected feature is the admission that the private plant has use for more or less exhaust steam for heating or for other processes and the confession that when this circumstance is taken into account the figures would be somewhat dependent on the conditions presented by each individual case.

This slight unbending is both rare and remarkable: but it is only a temporary lapse from an attitude of boastful superiority. In the next instant the speaker regains control of the situation and indicates that his brief condescension is a mistake, and that the proper way to effect a notable saving in coal is to buy power and light from the central electric station and use local steam heating when it cannot be obtained from a central heating system.

Notable saving, indeed! The testimony of various engineers before the Public Service Commission for the First District of New York, as given in preceding issues of *Power*, shows the speciousness of this argument. Wherever an isolated plant had use for all the exhaust steam from its pumps and engines, it was found considerably more expensive to purchase electrical energy from the central station and generate its own steam for heating.

Further than this, the amount of coal burned to furnish the required steam for heating only was practically the same as that required to produce both heat and electric current; so that, adding together the coal equivalent of the central-station current and the coal required for heating only, the sum was considerably greater than the amount of fuel used by the isolated plant in producing its own current and heat. The difference between the two amounts represented a plain loss of coal to the community. Yet the central-station advocates mouthily prate of "notable savings."

The truth of the matter is that during the heating season—which covers at least seven months of the year—no saving of coal, and certainly no saving of money, can be expected from the purchase of central-station current and heat from a central heating plant. During the remainder of the year the conditions are reversed, and if a plant has no use for its exhaust steam there is bound to be a waste of heat. But this is the situation in the central station the whole year round, for the heat in the exhaust from its engines or turbines is wasted continuously in the condensing water.

The purpose of the central station is plain. It is waging a campaign against the isolated plant with a view to its own aggrandizement. The sincere and commendable efforts of the Fuel Administration to save coal furnish a basis for the central station's claims to a position and a preferment to which it is not entitled except under certain advantageous conditions.

It is a regrettable and shameful fact that in every national crisis there have been individuals and corporations quick to seize on every emergency or predicament as a means of increasing their gains or more firmly intrenching themselves in their positions. We have invented various epithets with which to tag these groups, yet all the color, variety and elasticity of our language fail to produce a satisfactory term to express the contempt of honest men for those who seek unfair advantage under the guise of doing a patriotic service.

The Tale of the Gentle Baron

IN THE good old let-us-alone days, before the Government commenced its presumptuous interference with personal privilege and vested interests, a gentle baron built a castle upon one of the rivers which carried the products of the country to the sea and brought back the goods and money for which they had been exchanged.

And he and his strong-armed minions held up the traffic passing up and down, until, from each cargo and strongbox, a certain percentage had been delivered over to them.

What right had they to do it? They had no right—they just could.

But by and by the people began to wonder and to get restless, and as the exactions of the baron increased and the net returns for their labor diminished, they rose in their indignation and went with a petition to the king, asking, not that the baron be hamstrung or crucified, but that he be compelled to be more reasonable in his levies upon their industry.

And the king listened to their complaint and appointed a commission of good and wise men—acceptable to the baron—to inquire into the merits of their remonstrance.

And the baron sent out through all the kingdom and searched out the men of fairest speech, learned in the law and skilled in the arts of argument and sophistry, who, on his behalf, did represent to the commission that he, the baron, had been at vast expense in the erection of his castle and the perfection of his organization, that its maintenance was increasingly expensive, and his exactions really an inadequate return upon the investment and the risk and danger involved in the venture; that he had really done no wrong, but would not do so any more, and that if the learned commission so recommended, and their master, His Gracious Majesty, approved, the baron would agree not to raise his demands any further, but to be, for the present, content with the rate of exaction then existing.

And so the affair was settled, to the glory of the king, the credit of the commission, the profit of the wise men, and the satisfaction of everybody—except the people.

Drafting Mine Workers Reducing Coal Production

IT IS estimated that eighty million tons more coal will be required this year than was produced last year, and this figure is probably low, as unexpected additional estimates may be made. With a consumption of something like one hundred million tons by about three hundred and sixty non-war industries, there will have to be something like sixty million tons of coal saved by these individual power plants in one way or another if all are to be kept in operation.

That manufacturing plants working on war supplies will be kept running goes without saying, and the inevitable coal deficit must be borne by non-war industries, although millions are employed by them. That the fuel situation is and will be serious is evident to all. However, there are but few steam plants that cannot save some coal, and the methods of doing so have been pointed out so frequently that every reader's attention must have been directed to them.

No engineer can take things easy on the assumption that his particular industry will not be curtailed in the supply of coal. No engineer should take the ground that the few pounds he can save will be but a drop in the bucket in the conservation of sixty millions tons during the coming year. If enough engineers will put their steam plants in shape, this shortage of coal will be largely, if not entirely, overcome and there will be enough fuel for all. It is certain, however, that if the effort is not put forth, if the saving is not made, some plants that have managed to keep running during the last year will be obliged to shut down or run part time.

It is not wise to assume that the so-called nonessential plant will be closed first. It will require a Solomon to determine what industries are nonessential. It is doubtful if there are any. Even Dr. Garfield has failed to find any nonessential industries. Therefore the situation becomes all the more involved, and one non-war producing plant cannot be expected to receive any better treatment than another as regards coal.

Last winter and in the early spring the cry of the coal industries was the lack of railroad cars and locomotives, and this, together with railroad congestion, was largely responsible for the limited output at the mine. The last few weeks have shown a marked improvement in car supplies, but the production of coal has not been up to the desired standard, and the reason now given is not shortage of cars or locomotives, but lack of miners; in fact, some of the mines have been running only from fifty or sixty per cent. of their capacity. This shortage is largely due to drafting miners for military service, although many have secured work with other industries where higher wages are paid. This shifting of men was stimulated by the shortage of cars last winter, which resulted in part time for the miners.

From an outsider's point of view it would seem that there is lack of coöperation between the Fuel Administration and the draft officials. If the latter are determined to take every available mining man of draft age, regardless of whether his services at the mine would be of more benefit to the country as a whole, then there will be no improvement in the coal-producing fields, for miners are not made overnight.

If the fuel situation is as serious as the Fuel Administrators say it is, there would seem to be a pressing necessity for placing the facts before the draft officials and asking for the exemption of mine workers.

Hold-Up Men Still at Work

LAST winter, when New York was freezing and women and children stood in line for hours awaiting the privilege of buying a fifty-pound bag of coal, *Power* showed that at Perth Amboy there were hundreds of carloads of coal, that only a handful of men were employed in unloading it and that these worked only ordinary hours.

The *Official* (Government) *Bulletin* for Tuesday, June 25, contains the following:

> Reports received by the Fuel Administration show that the dumpings at South Amboy, N J., amount to only about 350 cars a day, and the total on hand, which was averaging 1200 cars a day, has been running during the last three or four days from 1800 to 1900 cars. Also the report for June 18 shows 405 cars running in pool No. 9 and 990 in pool No. 10, which would indicate that a number of transshippers are holding available at New York an excessive amount of permissible bunker coal, hoping to obtain the foreign bunker price.
>
> The letter of the Fuel Administration to J. W. Searles, of the Tidewater Coal Exchange, directs that he make an investigation of the matter, and where an account appears to be excessive to notify the shipper that unless the account is reduced to a normal basis and boats furnished promptly, the Fuel Administration will arrange to have the coal unloaded for other consignees.
>
> A general investigation as to conditions at other pools is directed, where, if like conditions appear, similar action by the Fuel Administration will be taken.

CORRESPONDENCE

Watch Your Step

The letter in the issue of May 7, page 670, by Walter N. Polakov, is timely and worthy of sincere consideration by all power-plant engineers. It is true, of course, that new equipment will not always reduce the cost of power as seems to be a prevailing idea among engineers. Money will not always buy economy any more than it will always buy pleasure and contentment; the application must be right in both cases. The expenditure of money may produce attractive surroundings, likewise the engineer may buy everything that should improve the plant economy, yet if he does not provide the essential talent and skill, he will fail to attain the highest degree of economy.

It seems also to be a prevailing idea that a large plant will always operate at higher economy. I think this is a great fallacy. I have been in large and small plants for the past fifteen years and know that if the extravagant and wasteful policies of some large plants were followed in small plants, the company would soon become insolvent. About eight years ago I saw a chief engineer transferred from a large central plant to a much smaller one, in which he practiced the same methods as in the large one. At the end of three months he had spent $7700 on repairs and changes in this 1000-kw. plant from which he could show no good results. Since then I have observed three similar cases.

I have data from steam plants of 1000 to 15,000 kw. in which the steam cost per 1000 lb. varied from 22 to 40c. Some small plants with return-tubular boilers, hand-fired, are generating steam for less money (including all charges such as interest, depreciation, taxes, insurance and overhead charges) than many of the large plants with water-tube boilers, stokers, fancy arches and settings. This is also often true of the unit cost of electricity per kilowatt-hour, ranging from 1.6 to 2.2c. The overhead expense in large plants is sometimes almost unbelievable.

About five years ago I was able to reduce the cost in a 1200-kw. power station as follows, averaged per month for one year. The average load for the first year was 7900 kw. and the the second year was 8200 kw. per day.

	Past Cost with Load of 7900 Kw.Hr. per Day	Present Cost with Load of 8200 Kw. Hr. per Day	Daily Saving Dollars	Per cent.
Coal	$1658.74	$1227.60	431.14	26
Labor	586.90	523.70	63.20	10.8
Coal and Labor	2245.64	1751.30	494.34	22

The foregoing statement was taken from the auditor's report, and the saving was not the result of new equipment such as stokers, superheaters, economizers, condensers, etc. We had precisely the same equipment at the end as at the start. We spent about three times as much for repairs as had been spent under the former management, amounting to $168 per month, or about 34 per cent. of the saving made on coal and labor, leaving a saving of $326 per month for one year.

Recently, I have been instrumental in reducing the power cost in a 15,000-hp. plant from 1.92 to 1.25c. per kw.-hr., or nearly 35 per cent. This improvement was due to the following (1) Load factor increased; (2) coal cost (price) reduced; (3) CO_2 in flue gas increased from about 9 to 11 per cent.; (4) steam leaks in steam turbine stopped; (5) vacuum increased from 25 to 27 in.; (6) number of pipefitters reduced from 8 to 4; (7) number of machinists reduced from 9 to 5; (8) brickmasons checked reducing time; (9) boiler cleaners reduced from 7 to 5; (10) firemen given bonus and increasing the number of laborers employed from 2 to 4.

This gives some idea of the inefficiency that existed, and there are others just as bad, or worse perhaps, in some respects.

WALDO WEAVER.

Franklin, Ohio.

High Boiler Setting

Referring to Mr. Strong's article on page 699 in the issue of May 14, it does seem difficult for some engineers to see the advantage of high setting. They do not appear to grasp the fact that it is the energy set free by combustion that does the work, not the visible flame sweeping the shell. It seems remarkable that he finds it necessary to clean fires only once in 24 hours. I have done some firing myself, but never could get through a ten-hour run, although starting with clean grates, without at least one cleaning. The quality of the coal would of course make a great difference. The high bridge-wall and one conforming to the curve of the boiler is another mistake that still prevails to some extent.

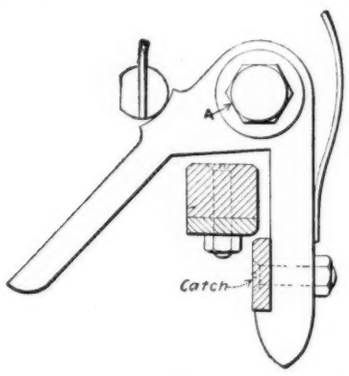
In regard to low setting injuring the fire sheets and tube sheets, I think the injury is caused by unconsumed matter, released from the fuel, and deposited on the comparatively cooler sheets, acting as a corrosive. Most of this is, in all probability, combustible that with the higher setting is burned and does not collect on the metal. I have heard engineers argue that the draft creates a vacuum in the front section of the furnace represented by the arc of a circle from the dead plate to a certain point on the shell proportionate to the draft, but if such is the case it would be only a partial vacuum through which the radiant heat would penetrate and would be far overbalanced by the more complete combustion and therefore quicker transfer of heat through the larger part of the heating surface represented by the remainder of the shell and tubes. With a shell boiler set from 4 to 5½ ft. above the grates, according to the size, a straight bridge-wall of medium height properly installed, together with smoke arches and with leaks in setting stopped and insulating covering in good shape, even with hand firing a larger percentage of coal can be saved in the boiler room than with all the other economies that can be effected elsewhere about the plant.

WILLIAM CHIDDECK.

Chicago, Ill.

Loose Grab Hook Causes Trouble

I had a lot of trouble with the latch blocks on a Corliss valve gear, but the remedy proved very simple. At the beginning of winter, the heavy load season, I found it necessary to change the catch plate on the head end every week or there would be trouble with the valve not picking up. It was some time before I found the cause.



GRAB HOOK LOOSE AT PIVOT

I was overhauling the valve gear one Sunday morning and happened to place my hand on the grab hook and found that it was loose and would rattle. I took the bolt out and put a shim around it to make it fit snug in the hole, and after I had drawn the bolt up tight the grab hook was just snug without binding. I had no idea then that this was the remedy for my worn catch plates, but I was delighted the following Sunday to find the one on the head end not worn "a little bit." It is now two months since I changed the plates last and from appearances they will last another two months. I always watch for such wear or slack now since finding out the trouble it may cause.

Maple Creek, Sask., Canada. F. G. BURFORD.

Tube Failure in Water-Tube Boilers

The editorial in the May 21 issue of *Power*, on "Tube Failure in Water-Tube Boilers" reminds me of an experiment an engineer once made to determine the action of the steam and water in the lower tubes of a Babcock & Wilcox type of boiler. Having failed in an attempt to prevent the blistering of the lower tubes of these boilers, by placing bushings in the front ends of the tubes, he constructed a miniature boiler having glass tubes.

After placing bushings in the upper ends of the tubes, he filled the boiler with water and applied a flame to the lower tubes. Large bubbles were observed to form over the flame and to pass each way in the tubes; that is, some would go forward, passing through the bushing and up the front headers, and the others worked down the tube and up the rear headers against the direction of circulation. This was also found to be the case to a limited extent when the bushings were removed and a brisk fire applied. Continuing the experiment, he placed the bushings in the rear ends of the lower tubes with the result that all steam bubbles traveled forward regardless of the intensity of the flame applied.

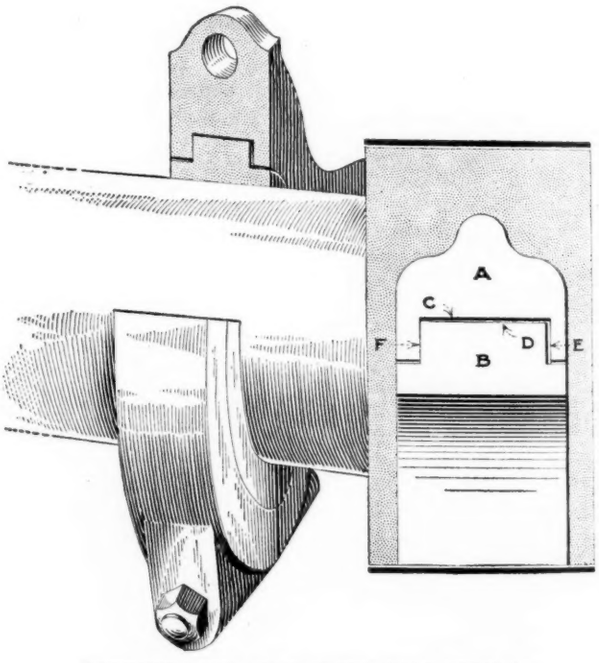
He reasoned that the same action observed in the glass tubes was taking place in the lower tubes of his boilers and that the blisters were caused by lack of water, which in turn was due to the interference of proper circulation by the rapid formation of steam, part of which, moving toward the rear headers, opposed the proper circulation and resulted in large areas of the tubes becoming dry and overheated. To overcome this, he removed the bushings from the front ends of the lower tubes and placed them in the lower or rear ends of the same, with the result that he has had no further trouble with blistered tubes.

Norwalk, Calif. A. C. MCHUGH.

Too Much Oil Causes Heating

It is sometimes asserted that an increase in the amount of oil fed causes an eccentric or other bearing to run at a higher temperature, but the explanation is not always satisfactory. Recently, an engineer told me of an eccentric, fitted with a grease cup, that always heated up somewhat when much pressure was kept on the grease by frequently screwing down the cup, but ran cool when the grease was fed sparingly. Anyone acquainted with the methods adopted to secure copious lubrication on high-speed engines and steam turbines and with the disastrous results that quickly follow a failure of the oil supply, will find it difficult to believe that a bearing surface will heat because well supplied with oil. It is possible that the heating of the eccentric referred to was caused in the following manner:

With copious lubrication the wedging action of the oil between the surfaces *E* of the strap and *D* of the eccentric causes considerable pressure, which may all



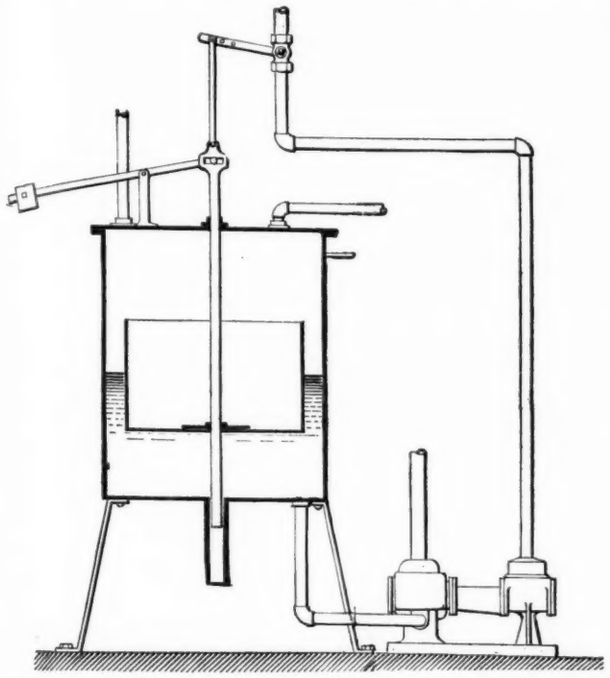
EXCESSIVE OIL MAY CAUSE SIDE THRUST

escape at one side or the other of the eccentric instead of partly on both sides, for if the oil escapes at *E*, for example, then the pressure will force the surfaces at *F* into close contact and these surfaces are thus transformed into a thrust bearing, notoriously difficult to lubricate, any slight amount of oil being quickly squeezed out. Further increase in the oil supply would only intensify these conditions; on the other hand, if the amount of oil fed is reduced, the pressure between the surfaces at *F* becomes less and the oil, though less in quantity, has a chance to work its way between them, keeping them lubricated and cool.

Prince Albert, Sask., Canada. C. H. WOODHOUSE.

Hot-Water Tank and Float

The arrangement shown is a departure from the ordinary hand-regulated means commonly used in plants for returning hot water to boilers, in that the float employed is of the open, or bucket, variety, is at all times full of water and is much more powerful



RETURN-WATER TANK WITH FLOAT TO CONTROL PUMP

than the hollow air-tight ones and not as likely to get out of order. The apparatus consists of a tank about 20 in. in diameter by 25 in. deep, on top of which is fitted a cover secured by bolts to an angle-iron ring riveted around the top of the tank. The open-top bucket is 16 in. in diameter by 10 in. deep and is made of 16-gage metal with the bottom reinforced where the stem is attached. The stem extends through the cover of the tank to the valve controlling the steam supply to the pump, as shown. To the bottom of the tank is fitted a guide about 18 in. long, for the lower end of the stem, to keep the float central in the tank. The lever is about 18 in. long and is supported on a fulcrum; the weight is about 20 lb. and is made to be moved along the lever to balance the float and obtain the correct adjustment of water level in the tank.

The operation of the apparatus is as follows: When the water flows into the tank, it fills the float until it overflows, and when the water level rises in the tank the counterweight raises the float and opens the regulating valve which admits steam to the pump. With proper adjustments the pump will work at a rate of speed depending on the supply of water coming into the tank, which can, of course, be made of any size to suit the quantity of water to be handled. The size described is found suitable in conjunction with a 6 x 4½ x 6-in. duplex pump. The pump must be set at least 12 in. below the tank so that the hot water may flow into it.

This device is quite simple to construct and operate, and water can be collected from any number of sources. It is also powerful and positive in its action. Makeup water can be added in any desired quantity, and it affords a ready means for introducing boiler compound, which can be fed slowly into the tank.

No originality is claimed for this contrivance, and it is described because it can be made and used in many plants where valuable hot water is wasted and will pay for itself many times over in a short time in heat units returned to boilers. JAMES O. OSBORNE.

Anyox, B. C., Canada.

Trouble in Synchronizing

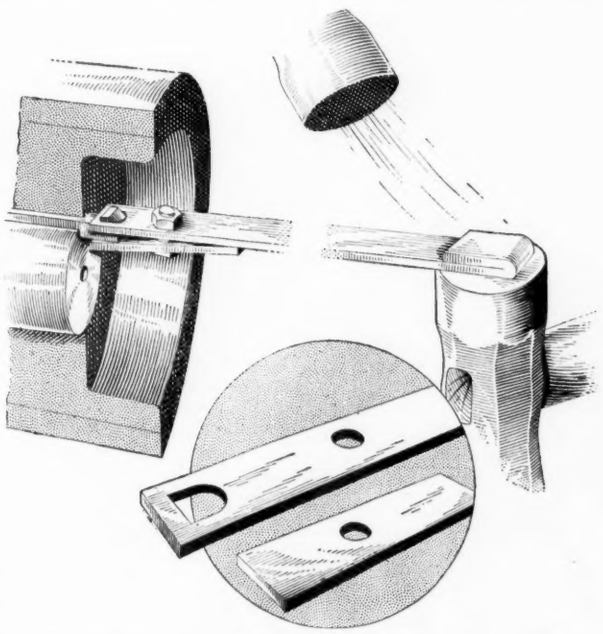
After shutting down our two 250-kv.-a. engine-driven alternators to repair a loose connection on the main oil switch, we found, on starting up, that the generators could not be synchronized, and adjusting the governors, etc., failed to effect a cure. We noticed that one generator had a pulsating instead of a steady hum and concluded that an uneven air gap was the cause of the irregularity.

Upon inspection of the setscrews regulating the air gap, we found that two were loose, allowing the stator to shift a little with each revolution. After adjusting the air gap and tightening the setscrews, the generators synchronized as usual. JAMES A. BARR.

Mt. Pleasant, Tenn.

Rig for Drawing Key From Motor Pulley

The illustration shows a rig I used to draw a key that was in an awkward place to get at. I used a bar ¼ by 2½ in. 3 ft. long, and a short piece for a clamp. The



EXTENSION CLAMP USED TO DRAW A KEY FROM MOTOR PULLEY

illustration shows the whole construction, so that no description seems necessary. Three sharp blows with a ten-pound hammer on the end of the bar made the key jump out at once. W. A. COOIL.

Ladysmith, B. C., Canada.

Some Float Pointers

The introduction of improved equipment in present-day power-plant practice and the tendency toward making apparatus automatic in action has resulted in a constant increase in the use of floats as part of power-plant equipment. In practically every case the proper, efficient and continuous operation of the apparatus using a float is largely dependent upon the reliability and stability of the float itself.

For practically all power-plant service the well-constructed copper-covered steel float is well suited because of its strength and its resistance to corrosion. Even where no pressure is encountered and where the lifting load or strain is very light, it is not good policy to make use of the lightly constructed sheet-copper float, ordinarily employed in plumbing work, because it is subject to collapse under abnormal conditions. Instead, an approved type of heavy float should be used exclusively. The steel shell imparts strength and rigidity, and the copper deposit prevents corrosion and pitting. Where highly corrosive liquors are encountered, floats can be

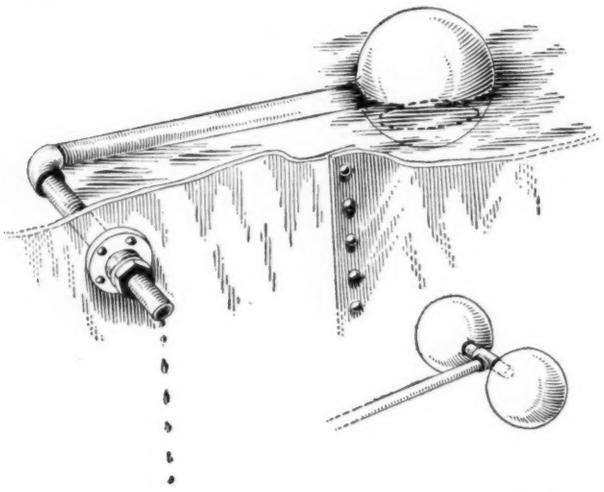


FIG. 1. HOLLOW FLOAT STEM

FIG. 2. DOUBLE FLOAT ON ONE STEM

made of aluminum, monel metal, glass or other special materials.

In order that a telltale may be provided to show when the float is leaking, it is well to use the ventilated type of float, in which the interior is connected to the atmosphere through a hollow float stem, Fig. 1. Should the float develop a leak, the water will trickle down through the stem and run out at the end, serving notice upon the operator that the float needs attention. Ordinarily, the float is installed in a closed vessel out of sight, and hence this telltale feature is desirable.

A common cause of trouble in connection with the proper maintenance of floats is using too small floats for the work, resulting in sluggish and uncertain operation and a greater variation in the water level maintained. Undue strain is also imposed on the float structure, with the result that breakage or collapse is likely to occur. If too small a float is in service, the condition can be remedied by the installation of another on the same stem, in the manner shown in Fig. 2. Additional power can often be obtained by making use of a larger lever arm on the float. Where space is restricted and the lifting load imposed on the float is heavy, the open or pan type of float can often be employed to advantage, though this type has the disadvantage of being subject to water-logging when the pan becomes filled with water.

For general purposes, and assuming that a float arm at least 18 in. long is provided, a regulating or control valve properly counterweighted up to about 2 in. should be handled by a float about 6 in. diameter. For sizes up to, say, 3½-in. valves a float equivalent at least to 6 or 7 in. by 10 in. should be employed, while sizes up to 5 in. should use not less than an 8 x 10-in. float.

Where sensitive operation is essential, a float of sufficient size should be used and then a counterweight should be placed on the lever of the regulating valve in order to counterbalance the weight of the float and parts so that the power generated by the rise and fall of the float is all expended in adjusting the regulating-valve disks and not in overcoming the resistance of the connecting mechanism.

Where rapid fluctuations and unsteady operation are encountered, the float mechanism can be steadied and made more sensitive in operation by providing a larger float and weighting it, and also providing a heavier counterweight on the lever arm.

The connection between the float and the connecting-rod operating the controlled valve should be made of brass or iron pipe sufficiently strong to insure a stiff, rigid connection and eliminate any spring. A ¼-in. connection for smaller sizes and ½-in. connection on larger sizes is generally used.

Frequently, where floats are used in water columns or other restricted locations, the life of the float is considerably reduced because of wear against the sides of the container, the comparatively soft copper being worn away from rubbing and contact with the coarser and harder iron. Where this condition is encountered, the wear should be prevented by the use of a winged guide made up of angle pieces soldered to the side of the float.

Where a leak has developed in a float, it can sometimes be remedied by coating the entire surface with another heavy deposit of copper. Ordinarily, soldering will not give satisfactory results because the solder will generally work loose and fall off. When a float develops a troublesome leak, it will be found in the long run that it is much more inexpensive and satisfactory to secure a new one rather than attempt to patch up the old one.

Philadelphia, Penn. M. A. SALLER.

Opening in Blowoff Pipe for Inspection

Eureka! I have an idea! The next time we repipe a boiler blowoff we will put a tee or, better still, a cross close up to the blowoff valve and between it and the drain line, so that any time we suspect that a valve is leaking, we can remove the plug from the fitting and see whether it is or not. We will be able to tell which valve is at fault and how serious the leak is. This may be the practice in many plants, but I have never happened to see it anywhere.

A direct-acting pump will sometimes overtravel and strike the head even when the steam valves are adjusted properly. This occurs when there is a leaky discharge valve that allows the discharge water pressure to back up and force the plunger forward after the steam inlet valve has closed. O. B. CRITCHLOW.

New Brighton, Penn.

INQUIRIES OF GENERAL INTEREST

Vacuum Breaker with Surface Condenser—What is the purpose of a vacuum breaker used with a surface condenser? J. J. B.

It is desirable to have a means of breaking the vacuum that is under control of the operator for increasing the back pressure, to assist in stopping the engine.

Reasons for Putting Lap on Corliss-Engine Valves—What are the reasons for putting lap on the valves of a Corliss engine? J. J. B.

Some lap is advantageous in preventing leakage past the edge of a valve when in a closed position. To obtain compression of the exhaust without giving the exhaust valves lap that would close the exhaust ports before the piston has reached the end of its stroke, it is necessary to advance the eccentric beyond its 90-deg. position, thus making both release and compression take place earlier. But, by advancing the eccentric, all valve events occur earlier in the stroke and lap must be put on the steam valves to hold them closed during the period of compression and until it is desirable to have live steam admitted to the cylinder.

Estimating Capacity of Centrifugal Pumps—What is the rule for figuring the capacity of a centrifugal pump? W. K. H.

The design and efficiency of centrifugal pumps are extremely variable, and no general rules can be laid down for estimating their capacity. Estimates of capacities based upon capacities determined by trial of a given pattern are the only estimates that can be relied upon, and apparently slight deviations from such standards may result in wide differences of actual capacity. Different sizes usually are designated by the number of inches of diameter of discharge-pipe connection. The average velocity of different makes of centrifugal pumps, when operating under normal conditions, is about 10 ft. per sec. and this, combined with the size of discharge, serves as a general index of capacity. Thus, a 4-in. diameter discharge would be $4 \times 4 \times 0.7854 = 12.566$ sq.in. of cross-sectional area, and a velocity of 10 ft., or 120 in., per sec. would make a discharge of $12.566 \times 120 \div 231 =$ about 6.5 gal. per sec., or $6.5 \times 60 = 390$ gal. per minute.

Returning Condensate from Exhaust Heating Apparatus—Our boiler-feed water is heated to about 212 deg. F. in a closed feed-water heater supplied with exhaust from steam hammers, and a large surplus of exhaust steam is discharged to the atmosphere. Cannot the feed water be raised to a higher temperature without increasing the back pressure on the exhaust, and would it not be more economical to pump the returns from the exhaust-steam heating coils through the heater in place of drawing on the city water supply? C. A. T.

Under the conditions stated it is not likely that without increasing the back pressure on the exhaust the feed-water temperature could be made perceptibly higher than the present 212 deg. F. by supplying the heater with water returned from the heating coils along with makeup water that would be necessary. But there would be a saving of fresh water by the amount at present discharged from the heating coils. At night or other times when the exhaust is not available for heating, there would be a saving of both heat and of water by returning the condensate of the heating apparatus to the boiler.

Advantages of Butt-Strap over Lap Joints—Why are butt-strap joints for boiler plates stronger than lap joints? B. S.

With lap joints the rivets are in single shear, and the eccentric pull across the joint has a tendency to bend or crack one plate along the edge of the other. In addition to this, the rivets of the outer row must be set close enough together to afford a calking pitch and the strength of the joint cannot be in excess of the strength of plate remaining between the rivet holes of a calking pitch. In a butt-strap joint the rivets of the inner rows are in double shear, and those rivets, being twice as strong as the single-shear rivets of a lap joint, may be set close enough to afford a calking pitch and, besides, may be assisted by outer rows of rivets in single shear between the main plate and the inner butt strap. As the outer rows need not be set close enough together for a calking pitch, there may be a greater amount of stock and greater strength of the plates between the rivet holes than is obtainable with the calking pitch required for the outer row of rivets of a lap joint.

Lap of Valve and Greatest Port Opening—The travel of a D slide valve is 7½ in. When in position for cutoff at one end, the valve must be moved a distance equal to 0.8 of the travel before it is in position for the return stroke of the piston. The lead is ¼ in. What is the lap of the valve and what is the greatest port opening? F. S.

Lap is the amount the valve extends over the steam port when the valve is in its central or mid-position. It is assumed that each end of the D slide valve has the same amount of lap. The distance the valve would be moved to one side to obtain the lead for the return stroke would be $0.8 \times 7\frac{1}{2} = 6$ in., but as this distance includes ¼ in. lead, then in the original position with one end at cutoff, the other end would extend $6 - \frac{1}{4} = 5\frac{3}{4}$ in. over its port. As this distance equals the sum of the laps of both ends, they being the same, the lap of the valve is one-half of $5\frac{3}{4} = 2\frac{7}{8}$ in. The greatest port opening obtainable is one-half of the valve travel minus the lap. When the valve is in mid-position, each end overlaps its port 2⅞ in. and that amount of movement of the valve to one side of the mid-position would be required before the valve would begin to uncover the port. As the greatest travel on each side of the mid-position is one-half of 7½ in., or 3¾ in., then with the valve set to travel equally over the ports the greatest port opening would be $3\frac{3}{4} - 2\frac{7}{8} = \frac{7}{8}$ inch.

Location of Back-Pressure Relief Valve—We are at present using exhaust steam for heating boiler-feed water in a closed heater, and it is proposed to use the exhaust at 2 lb. back pressure for evaporators. Would the power lost from back pressure be increased if the steam supply to the evaporators is taken out of the exhaust connection to the heater and the pressure on the evaporator line is regulated by a back-pressure relief valve on the discharge side of the heater? P. G. D.

It is immaterial whether the back-pressure relief valve is on the line to the evaporators or the pressure is relieved by a back-pressure valve beyond the heater provided the present discharge of the exhaust through the heater does not create more than 2 lb. back pressure. The back pressure due to the heater with a given load on the engine can be determined by indicating the engine with and without exhausting through the heater and its connections. The difference of back pressure will show how much back pressure can be added at the back-pressure relief valve placed at the heater outlet to make 2 lb. back pressure for the supply to the evaporators. The best method of insuring a supply of exhaust steam to the evaporators, and relieve the heater of responsibility for back pressure, would be to connect the exhaust discharge from the heater by a smaller-sized circulating pipe to the evaporator line and regulate the back pressure by controlling the supply to the evaporators.

[Correspondents sending in inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Convention of the New England States Association of the N. A. S. E.

THE annual convention of the New England States Association of the N. A. S. E. in combination with the New England Association of Commercial Engineers was held at Bridgeport, Conn., July 10-13, with headquarters at the Stratfield Hotel. Every local association in the New England States was represented. The attendance of delegates was unusually large this year, and many past national presidents and men of prominence in the engineering field were among the visitors.

The main hall of the State Armory, a short walk from the headquarters, was conveniently arranged and tastefully decorated for the mechanical display of the New England Association of Commercial Engineers. The booths were occupied by 110 firms, and there was a generous attendance of the engineers of Bridgeport and vicinity. The sessions of the delegates were held in the spacious hall in the basement of the Armory. The business of the convention was disposed of with harmony and dispatch. Many important measures of a helpful nature to the Government at the present time were unanimously adopted.

The opening of the exhibit hall took place on Wednesday evening. John A. Morehouse, president of the N. E. A. C. E., briefly addressed the assemblage and then introduced the Hon. Clifford B. Wilson, mayor of Bridgeport, who goodnaturedly welcomed the convention. He expressed the hope that the stay of the visitors would be pleasurable and profitable and cautioned them to be conservative in every possible way, as the war must go on until there is an unquestioned victory for the Allies. Major James H. Myrick, in responding for his association, paid a patriotic tribute to Bridgeport and assured the mayor that the N. A. S. E. and the New England Commercial Engineers seconded his remarks to a man. Judge J. J. Walsh, of Norwalk, Conn., explained the causes that led up to the war and showed how the United States had joined the Allies for the sake of justice and humanity. Charles M. Dowd, chief engineer of St. Vincent's Hospital, Bridgeport, closed the exercises with a short speech of genuine welcome.

On Friday morning at 10 o'clock the official opening of the convention of the New England States N. A. S. E. took place in the meeting hall of the delegates. Frank D. Anderson, chairman of the local committee, occupied the chair. Joseph Eccleston, president of the New England States Association, greeted the delegates and congratulated them upon the big attendance. Theodore N. Kelsey, past national president, urged the delegates to be faithful and patient for the present, to stick to their jobs. He told of the sacrifices that many members of the N. A. S. E. had made, and assured them that the future of the engineer was a bright one. John H. Waterman, of the War Industries Board, of Washington, gave an instructive talk on the manner of the distribution of equipment and supplies, and showed the importance of the priority of essentials over the nonessential demand. Judson Pratt, of Cincinnati, the father of the red, white and blue button of the N. A. S. E., extended a cordial invitation to the engineers to the next national convention at Cincinnati in September next and assured them of a hearty welcome. Thomas H. Hawley, of Boston, emphasized the importance for the immediate conservation of food, fuel, power and labor, and suggested that a committee be appointed at this convention to persuade all members of the local associations throughout New England to economize in every possible way in their plants. John Cousins, first national president, in a brief address, told the delegates of the ever-present necessity for the educational advancement of the engineer, and wished prosperity to the organization. The convention then went into executive session, and after the necessary committees were appointed an adjournment was taken until the afternoon session at 2 o'clock.

On Friday evening at 9 o'clock a smoker was held in the auditorium of the Stratfield Hotel. The talent included Bert Self, United States Rubber Co.; Monroe Silver, Dearborn Chemical Co.; Billy Murray, Jenkins Bros.; Bob Jones, Oiline Refining Co.; L. H. Seere, Anchor Packing Co.; James Donnelly, Wm. R. Winn Co.; and Jack Armour, of *Power*. Frank Martin was the master of ceremonies. During a recess in the entertainment John A. Morehouse was presented a gold watch, the gift of the Commercial Engineers, Theodore Kelsey making the presentation speech.

On Saturday afternoon an outing and clambake was held at Lordship Park. A baseball game between the engineers and supply men was won by the former by the score of 10 to 4.

At the final meeting of the delegates the following officers were elected: Andrew Waite, Portland, Me., president;

DELEGATES, SUPPLYMEN AND VISITORS TO THE NEW ENGLAND

Warren Goodrich, Bridgeport, Conn., vice president; James H. Henderson, Boston, Mass., secretary; Walter H. Damon, Springfield, Mass., treasurer; Henry J. Easton, Bridgeport, Conn., conductor; John Graham, Fall River, Mass., doorkeeper. At this meeting a resolution was unanimously adopted requesting John H. Waterman to carry back to Washington the unqualified indorsement of the convention for the great work the War Industries Board is doing.

The New England Association of Commercial Engineers elected officers as follows: Adelbert W. Petti, president; Harry H. Atkinson, vice president; James W. H. Myrick, treasurer; Claude D. Allen, John A. Morehouse, Frank S. Bulkley, directors.

Springfield, Mass., was selected by the delegates for the next annual convention in July, 1919.

Charleston-Nitro Transmission Line Completed

With the completion of the Virginian Power Co.'s new transmission line from Charleston to Nitro, W. Va., a distance of about 16 miles, current was recently turned into the new line for the first time. The company has a contract to supply the large $90,000,000 Government powder plant at Nitro with power. In accordance with the provisions of that contract the Virginian company is building another transmission line from its plant at Cabin Creek Junction over Winifrede Mountain and down Coal River to St. Albans, at which point the line will cross the river and connect with the Government plant.

By October the company expects to have another turbine unit installed, which will enable it to meet all Government requirements for power and which will give the plant of the Virginian company a total capacity of 60,000 kw. as against 30,000 kw. at the present time. The company has just completed the installation of an additional turbine unit. These improvements were started some time ago, but were not completed until after the Virginian company had entered into its present arrangements with the Government.

Overseas Forces Demand Increasing Gasoline Supply

The constantly growing demand for gasoline to supply airplanes and motor transports now with the American overseas forces in France will necessitate continually increased shipments to the American Expeditionary Forces. Present stocks of gasoline, however, are now ample to supply the war demand and to allow the normal rational consumption in this country to continue. The abnormal waste that characterizes the use of gasoline in motor-propelled vehicles, however, must be brought to an immediate halt. The Fuel Administration is urging everyone concerned in the production, distribution and consumption of gasoline to eliminate every possible point of waste. Unless this is done the present supply may in a short time become an actual shortage. If this condition develops, the Fuel Administration will not hesitate to make effective enforced conservation methods, which, however, up to the present have not been necessary.

Gorge Power-Plant Turbine Wrecked

According to a newspaper item two men were injured and ten others imperiled by the failure of the rotor of a turbine at the Gorge Power House of the Northern Ohio Traction and Lighting Co., Saturday, July 6. Clyde A. Gilmore, of the Westinghouse Co., Pittsburgh, an electrical expert, was seriously cut about the limbs and back by flying pieces. T. J. Stewart, of Cuyahoga Falls, was also hurt. Both men were taken to the hospital.

The accident was due, it is said, to the governor getting out of order, thus permitting the turbine to race at such a speed that it exploded. The parts were thrown in all directions, and the casing of the turbine also was wrecked. The concrete roof and walls gave evidence of the velocity with which the pieces of metal had been hurled against them.

Ten men escaped without injury, and there was no tie-up of power on account of the wrecking of the turbine, other machines being capable of meeting all demands.

If it is possible to obtain data, a full description of this accident will be published.

Some particulars of an atmospheric pumping engine, at Elsecar Colliery, Yorkshire, England, are given in a letter in a recent number of the *Great Central Railway Journal*. The engine was erected in 1787 and is still running well. The cylinder is 4 ft. diameter, with a stroke of 5 ft. The beam is 24 ft. long. The condensing water injection takes place right into the cylinder. The piston is packed with spun-yarn, kept air-tight in the usual way, with a layer of water. The engine makes six strokes per minute. The pump barrel is 18 in. diameter and elevates the water about 120 ft. There are two plain cylindrical boilers, with exterior fires; each is 22 ft. long by 7 ft. diameter, and they carry a working pressure of 2½ pounds.

STATES CONVENTION OF THE N. A. S. E. AT BRIDGEPORT, CONN.

The Administration Water-Power Bill

The Joint Committee Makes Many Changes in the Original Draft of the Bill—Three Entirely New Sections Are Added and Several Practically Rewritten

THE Administration's water-power bill, as whipped into shape by the joint committee after numerous hearings, is now before the Congress. The original bill contemplated a commission composed of the Secretaries of War, Interior and Agriculture, with an executive officer at $10,000 and a secretary at $5,000 a year. In the revision the executive officer is eliminated, and the President appoints the chairman of the commission, presumably from among the constituent secretaries. The civil-service provision for employees of the commission is cut out.

In the original bill "municipal purposes" was defined as "all purposes within municipal power as defined by the constitution or laws of the state, or by the charter of the municipality, *where any such purpose is directly pursued by the municipality itself with the primary object of promoting the security, health, good government or general convenience of its inhabitants.*" The portion in italics has been stricken out.

The new bill specifies, as an additional duty of the commission, "to make investigations as to whether the power from navigation dams can be advantageously used by the United States for its public purposes, and what is a fair value of such power." It is further provided that "whenever the contemplated improvement is, in the judgment of the commission, desirable and justified in the public interest, for the purpose of improving or developing a waterway or waterways for the benefit of interstate or foreign commerce, a finding to that effect shall be made by the commission and shall become a part of the records of the commission. Provided, that in case the commission shall find that any navigation dam may be advantageously used by the United States for its public purposes, no license therefor shall be issued until two years after it shall have reported to Congress the facts and conditions relating thereto."

Recapture or Revocation of License

A great deal of the discussion before the joint commission dealt with the provisions for recapture or revocation of the license, and for the renewal of the license upon expiration, special objection being urged against the renewal of the license for less than 50 years. The original draft provided that "each license under this act shall be issued for an original period of 50 years, *unless a shorter time is agreed upon between the applicant and the commission, or is necessary in order that licenses for parts of the same project shall terminate on the same date. Licenses for subsequent periods of such duration and under such conditions as may be prescribed by then existing laws and regulations shall be tendered as provided in Section 15 hereof unless and until at the termination of the original or of any subsequent period the properties are taken over and compensation made as provided in Sections 14 and 15 hereof. After the termination of the original or of any subsequent period the licensee, upon application for a new license, shall continue in undisturbed possession and use under the conditions prescribed in the license last held until a new license is tendered, or if the properties are taken over as provided in Sections 14 and 15 hereof, until so taken over and compensation made as provided therein.*" The portion in italics is stricken out.

In the new draft the following has been added: "Licenses may be revoked only for the reasons and in the manner prescribed under the provisions of this act, and may be altered only upon mutual agreement between the licensee and the commission after public notice is given for 90 days."

The old draft said: "Licenses may be revoked only for cause, and in the manner prescribed in Sections 13 and 26 thereof."

The original draft provided that "in issuing licenses hereunder the commission may in its discretion give preference to applications for licenses by states and municipalities *for developing power for state and municipal purposes*, provided the plans for the same are deemed by the commission to be *adequate* to conserve and utilize in the public interest the navigation and water resources of the region."

The word "adequate" has been changed to "best adapted," and the rest of the portion italicized has been left out.

Inasmuch as by the rest of the section the commission may give preference to anybody else who has the project "best adapted," etc., the preference for states and municipalities contemplated by the earlier draft seems to have been annulled and the section simply says in effect that the commission *may* in its discretion give preference to any applicant whose plans are best adapted to conserve and utilize in the public interest the navigation and water resources of the region.

Government Development of Projects

An additional section in the new draft reads as follows: "That whenever, in the judgment of the commission, the development of any project should be undertaken by the United States itself, the commission shall not approve any application for such project by any citizen, association, corporation, state or municipality, but shall cause to be made such examinations, surveys, reports, plans and estimates of costs of the project as they may deem necessary, and shall submit its findings to Congress with such recommendations as it may deem appropriate concerning the construction of such project by the United States."

The original draft provided "that no transfer of any license, or of the rights thereunder granted, except by tax sale, *or trust deed or mortgage issued for the bona fide purpose of financing the business of the licensee* shall be made without the written approval of the commission." The words in italics have been stricken out.

The original draft provided that no changes should be made in the approved plans of any dam or other project in excess of 500-hp. capacity prior to the approval of the commission. In the new draft this is changed to 100 hp.

The following provision for amortization reserves is inserted in the new draft: "That out of surplus earnings, if any, accumulated in excess of a specified rate of return upon the net investment of the licensee in any project or projects under license, the licensee shall establish and maintain an amortization reserve, which reserve shall, in the discretion of the commission, be held until the termination of the license, or be applied from time to time in reduction of the net investment. Such specified rate of return, and the proportion of such different earnings to be paid into and held in such reserves, shall be set forth in the license, and the license may provide as to any balance of such surplus earnings that the same in whole or part shall be used in reduction of rates and annually divided and repaid to and among the persons who have paid such rates, according to the amount paid by each such person during the year."

Rental Charges To Be Paid Government

The section relating to rental to be paid the Government read in the original draft as follows: "That the licensee shall pay to the United States reasonable annual charges in an amount to be fixed by the commission. *A schedule of annual rates of charge, which rates shall in no case be less than 10c. per horsepower per annum, shall be set forth in each license. Such schedule of rates shall be fixed by the commission under general methods to be prescribed in the regulations, and in fixing such schedules the commission shall give due consideration to any benefits accruing to the licensee through the construction, operation or maintenance by the United States of any navigation structures or headwater improvements, and shall also give due consideration to and due credit for the annual interest, maintenance and*

operation cost to the licensee on account of any lock or locks or other aids to navigation constructed, maintained or operated at the expense of the licensee: Provided, That licenses for the improvement, transmission or distribution of power by states or municipalities *solely for state or municipal purposes* may be issued without charge, and that licenses for the development, transmission or distribution of power for the utilization by the licensee of national forest timber to the extent that power developed under licenses so used, and for domestic mining or irrigation use in projects of not more than 50 hp. capacity, may be issued without charge, but in no case shall a license be issued free of charge for the development and utilization of power created by dams or other works constructed and owned by the United States for the improvement of navigation."

The portion in italics has been stricken out, and the section rewritten to read as follows: "That the licensee shall pay to the United States reasonable annual charges in an amount to be fixed by the commission. When licenses are issued that contemplate the use of navigation dams or other structures owned by the United States, in the discretion of the commission the charges to be paid by the licensee may be readjusted at periods of not less than 10 years, in a manner to be described in each license, provided that licenses for the development, transmission or distribution of power by states or municipalities shall be issued and enjoyed without charge, to the extent that such power is used by such state or municipality for state or municipal purposes, and that licenses for the development, transmission or distribution of power for domestic, mining or irrigation use in projects of not more than 50 hp. capacity may be issued without charge, but in no case shall a license be issued free of charge for the development and utilization of power created by any navigation dam, and that the amount charged therefor in any license shall be as nearly as possible that ascertained by the commission to be the value of such power."

The new draft contains a provision "that combinations, agreements, arrangements or understandings, express or implied, to limit the output of electrical energy, to restrain freight, or to fix, maintain or increase prices for electrical energy or service are hereby prohibited."

The original draft provided "that such licensee shall, to the extent necessary to preserve and improve navigation facilities, *at least equivalent to those existing prior to the construction of such dams,* construct in whole or in part without expense to the United States in connection with such dams, a lock or locks, booms, sluices or other devices for navigation purposes, etc." In the new draft the words in italics are omitted.

Provision for Navigation Facilities

The original draft provided that "the licensee shall from time to time, after the project has been partly put into operation, construct such portions of the balance of such development *as the commission may direct and within such reasonable time as may be specified by it* so as to supply adequately the reasonable market demands until such development shall have been completed." The portion in italics has been stricken out.

A provision which had been in the original draft but was stricken out of the draft as submitted to the joint committee provided "that such fair value shall not include or be affected by the value of any lands, rights-of-way or other property of the United States licensed by the commission under this act, by the license or by good will, going value or prospective revenues; provided further that the values allowed for water rates, rights-of-way, lands or interest in lands shall not be in excess of the actual reasonable cost thereof at the time of acquisition by the lessee."

This provision has been restored in the redrafted bill, but "fair value" has been changed to "net investment," and "lessee" at the end to "licensee."

The former draft provided that "if the United States does not at the expiration of the original license, *or of any license subsequently issued,* exercise its rights to take over, maintain and operate any project or projects of the licensee, as provided in Section 14 hereof, the commission is authorized to issue a new license, etc." The portion italicized has been eliminated. In the same section the following proviso of the former draft has been left out: *"Provided, however, that if any project or projects shall not be taken over by the United States or by a new licensee, the terms and conditions imposed upon the original licensee on any new license tendered shall not be such as to impair the net investment of the licensee in said project or projects."*

Three New Sections Added

Three entirely new sections have been added to the bill, as follows:

Sec. 19. That as a condition of the license, every licensee hereunder which is a public-service corporation, or a person, association or corporation owning or operating any project and developing, transmitting or distributing power for sale or use in public service, shall abide by such reasonable regulation of the services to be rendered to customers or consumers of power, and of rates and charges of payment therefor as may from time to time be prescribed by any duly constituted agency of the state in which the service is rendered or the rate charged. That in case of the development, transmission or distribution, or use in public service of power by any licensee hereunder or by its consumer engaged in public service within a state which has not provided a commission or other authority with power to regulate and control the services to be rendered by such licensee or by its consumer engaged in public service, or the rates and charges of payment therefor, or the amount or character of securities to be issued by any of said parties, it is agreed as a condition of such license that jurisdiction is hereby conferred upon the commission, upon complaint of any person aggrieved or upon its own initiative, to exercise such regulation and control until such time as the state shall have provided a commission or other authority for such regulation and control: Provided, That the jurisdiction of the commission shall cease and determine as to each specific matter of regulation and control prescribed in this section as soon as the state shall have provided a commission or other authority for the regulation and control of that specific matter.

Sec. 20. That when said power or any part thereof shall enter into interstate or foreign commerce the rates charged and the service rendered by any such licensee, or by any subsidiary corporation, the stock of which is owned or controlled directly or indirectly by such licensee, or by any person, corporation or association purchasing power from such licensee for sale and distribution or use in public service shall be reasonable, nondiscriminatory, and just to the consumer, and all unreasonable, discriminatory and unjust rates or services are hereby prohibited and declared to be unlawful; and whenever any of the states directly concerned has not provided a commission or other authority to enforce the requirements of this section within such state, or to regulate and control the amount and character of securities to be issued by any of such parties or such states are unable to agree through their properly constituted authorities on the services to be rendered or on the rates or charges of payment therefor, or on the amount or character of securities to be issued by any of said parties, jurisdiction is hereby conferred upon the commission, upon complaint of any person aggrieved, upon the request of any state concerned, or upon its own initiative to enforce the provisions of this section, to regulate and control so much of the services rendered, and of the rates and charges of payment therefor as constitute interstate or foreign commerce and to regulate the issuance of securities by the parties included within this section.

The administration of the provisions of this section, so far as application, shall be according to the procedure and practice in fixing and regulating the rates, charges and practices of railroad companies as provided in the Act to regulate commerce, approved Feb. 4, 1887, as amended, and that the parties subject to such regulation shall have the same rights of hearing, defense and review as said companies in such cases.

In any valuation of the property of any licensee hereunder for purposes of rate making, no value shall be claimed by the licensee or allowed by the commission for any project or projects under license in excess of the value or values prescribed in Sec. 14 hereof for the purpose of purchase by the United States.

Sec. 21. That when the grantee is a municipal corporation, or a political subdivision of a state, or a public service agent of a state, or a public utility or service corporation, and cannot acquire by contract or pledges the right to use or damage the lands or property of others necessary to the

construction, maintenance or operation of any dam, reservoir, diversion structure, or the works appurtenant or accessory thereto, it may acquire the same by the exercise of the right of eminent domain in the District Court of the United States for the district in which such land or other property may be located, or in the state courts.

The following section has been practically rewritten:

Sec. 23. That the provisions of this Act shall not be construed as revoking any permit or valid existing right-of-way heretofore granted, or as revoking any authority heretofore given pursuant to law, but any person, association, corporation, state or municipality holding or possessing such permit, right-of-way or authority, may retain the same commission, or with any regulation or lawful order of the commission, or of the Secretary of War, issued or made in accordance with the provisions of this Act, shall be deemed guilty of misdemeanor, and on conviction thereof shall, in the discretion of the court, be punished by a fine of not exceeding $1000, in addition to other penalties herein prescribed or provided by law, and every month any such license, or any such person, shall remain in default after written notice from the commission, or from the Secretary of War, shall be deemed a new and separate offense punishable as aforesaid.

Also the following:

Sec. 27. That nothing herein contained shall be construed as affecting or intending to affect or in any way to interfere with the laws of the respective states relating to the control, appropriation, use or distribution of water used in irrigation or for municipal or other uses, or any vested right acquired therein.

Regulations Concerning Clean Coal

The regulations of the United States Fuel Administration effective Mar. 11, 1918, have been canceled and a new set of regulations has been substituted, which went into effect at 7 a.m., June 1, 1918, and are as follows:

SECTION I. After the effective date of this order no bituminous coal shall be sold, shipped, or distributed if the same contain such a quantity of rock, slate, bone, sulphur, fire clay, shale, or such other form of impurities that it would not have been considered merchantable prior to Jan. 1, 1916.

SEC. II. District Representatives are hereby authorized and directed forthwith to appoint an adequate number of coal inspectors in each of their districts. The appointment of such inspectors and the fixing of the compensation to be received by them shall be subject to the approval of the United States Fuel Administrator or such other person as may be designated by him for that purpose.

SEC. III. It shall be the duty of such coal inspectors:

(1) To familiarize themselves with the conditions under which coal is produced and prepared for market in the particular territory to which they are assigned, so as to enable them intelligently to determine the quality of the coal being produced and whether the same has been reasonably cleaned of impurities, so as to conform to Section I hereof, and to suggest and recommend such different or additional methods or means as they deem necessary for use by mine operators or mine employees to effect an improvement in the quality of the coal produced in their respective territories and to prevent the production of coal which fails to comply with Section I hereof.

(2) To inspect coal-mining operations and coal produced in the territory assigned to them periodically and at such times as may be directed by the District Representative in charge of the territory in which they are working.

(3) To make daily reports to such District Representatives, which shall show:

(*a*) Description and location of each lot of coal and of each mine inspected, together with full detailed information covering the methods employed at such mine in producing coal and preparing the same for the market.

(*b*) Condition of coal as loaded, stating specifically whether in their judgment same conforms to Sec. I hereof.

(*c*) Any suggestions or recommendations which they deem it advisable to make for improvement in the quality of the coal being sent to market from their respective territories.

(4) To make reports in quadruplicate, the original to be forwarded to their District Representative, one copy to the Inspection Section, United States Fuel Administration, Washington, D. C., one copy to the operator whose mine or coal has been inspected, and one copy to be retained by the inspectors themselves.

(5) To coöperate fully in every reasonable and practicable way with mine operators and mine employees in an earnest endeavor to have coal properly cleaned and prepared for market.

SEC. IV. If any such inspector shall find that any coal is about to be shipped which in his opinion does not conform to the requirements of Section I hereof, said inspector is hereby authorized to condemn such coal and immediately to notify in person, or by wire, and in writing, both the operator producing such coal and the District Representative in charge of the territory in which such coal is located, and to forward to such District Representative and to the Inspection Section, United States Fuel Administration, Washington, D. C., a full report of his investigation and condemnation, stating specifically the location of the coal condemned, i. e., whether on the ground, in a bin, or other storage place, on barges at river, in tipples, or in railroad cars, together with the names or numbers of such barges and the initials and numbers of such cars. Upon receipt of such notification, the District Representative, if he approves of such condemnation, shall immediately give notice of his approval to the operator producing such coal confirming such notice in writing, and thereupon such operator shall have the following options:

(1) To take such steps as may be necessary, after unloading the same, if in railroad cars or barges, to make the same conform to the provisions of Section I hereof to the satisfaction of the inspector condemning the same, or

(2) To ship such coal and invoice the same with a deduction of 50 cents per net ton from the applicable Government mine price, or from the contract price if such coal has been sold under contract and the contract price differs from said Government price.

Each invoice for such condemned coal shall have indorsed thereon the following: "A reduction of 50c. per net ton has been made on the sale of this coal because the same fails to comply with the standard of clean coal fixed by the United States Fuel Administrator."

Operators whose coal has been condemned shall immediately submit to the District Representative and to the Inspection Section, United States Fuel Administration, Washington, D. C., a written report of the disposition of such coal, and, in the event of the same having been sold, copies of all invoices must be attached to such report.

SEC. V. If repeated or flagrant violations of Section I of this regulation by any one operator are reported to a District Representative, he shall immediately make a full and complete report thereon to the Inspection Section, United States Fuel Administration, Washington, D. C., with his recommendations as to the action to be taken by the United States Fuel Administrator in respect thereto.

SEC. VI. If any inspector is of the opinion that coal being produced in any designated part or in the whole of any particular mine is naturally of such character as to be unfit for market, he shall immediately notify the operator producing the coal and the District Representative in charge of the territory in which the mine is located in person or by wire and in writing, and shall forward a written report to said District Representative and to the Inspection Section, United States Fuel Administration, Washington, D. C., stating in full the result of his investigation. Upon receipt of such written report said District Representative shall immediately make such further investigation as may to him seem proper and necessary, and promptly transmit all essential information obtained by him, together with his recommendation, to the Inspection Section, United States Fuel Administration, Washington, D. C. Upon receipt of said report from said District Representative the said Inspection Section shall recommend to the United States Fuel Administrator, or such person as he may designate for that purpose, whether or not it is advisable to order that no further shipments shall be permitted from such mine or any specified part thereof.

SEC. VII. The term "mine"as used in this order shall be construed to cover any operation by which any kind of coal other than anthracite is produced or recovered from any source.

In hardening and tempering a chisel, the best way, says the *English Mechanic*, is to heat it to a very dull red for a good inch up from the edge, holding the tongs in the left hand and in the right a rub stone—a piece of broken grindstone or emery wheel, or, failing these, a slip of emery cloth wrapped around a small file. Dip the chisel for about half an inch until it just turns black, then withdraw it from the water and let it rest against the side of the pail, so as to steady it; rub it sharply with the stone, so as to brighten it, and watch the color as it runs down from the part which is still hot, and when the edge is of a deep plum color, verging on blue, dip it right out.

Utilization of Fine Grades of Anthracite*

Eighty million tons of anthracite will likely be mined this year. The production of culm is approximately 7 1/2 per cent. of the total output of anthracite. Coking bituminuous coal is best with which to mix culm or other fine anthracite. About 30 per cent. fine anthracite seems to be the limit that can be successfully used with bituminous.

JOHN E. MUHLFELD:[1] The indications are that during the current coal year (Apr. 1, 1918, to Mar. 31, 1919) about 80,000,000 tons of anthracite coal will be mined for distribution, as compared with 77,000,000 tons during the previous year, of which latter amount about 5,500,000 tons were exported. Of this year's output probably 25,000,000 tons will be steam sizes, leaving 55,000,000 tons for domestic and specialized uses.

New England alone will require about 13,000,000 tons of anthracite, exclusive of steam sizes, whereas, according to the Anthracite Committee of the United States Fuel Administration, its allotment is now placed at about 10,500,000 tons.

The exclusion of almost one-half of the 48 states in the Union from participation in this year's anthracite production, and a shortage of 25,000 to 50,000 men from the number normally engaged in the anthracite mining field, in combination with the lack of water and rail-transportation facilities, establishes the immediate necessity for reclaiming and utilizing every ton of anthracite silt, slush and culm that is now being produced or which is stored above ground.

Consumption of Anthracite at the Mines

As about one ton of anthracite is now consumed at the mine in the production of steam to mine each eight or nine tons produced, the logical use to which these waste sizes should be put is in the production of power, heat and light at the mines. By this procedure useful byproducts of from 11,000 to 12,000 B.t.u. heat value per pound—which are now being wasted by diversion to streams, backfilling into abandoned mines, or by dumping in culm banks, and which represent about 10 per cent. of the total tonnage mined—can be made to release 85 to 90 per cent. of the commercial-size anthracite that is now being consumed for mine steam generation for use in locomotives and at industrial plants, situated nearest the points of production. In other words, in the production of 80,000,000 tons of domestic and steam anthracite during the current coal year, the reclamation and utilization of the silt, slush and culm byproduct for mine-operation purposes would release about 8,000,000 additional tons of steam-size anthracite that could be diverted to commercial use and more than make up the shortage in supply.

By pulverizing this byproduct anthracite and burning it in suspension, as oil or gas is burned, it can be used for stationary-boiler purposes without the admixture of any other fuel, and easily produce from 100 to 150 per cent. of the rated boiler capacity. For locomotives it can be utilized by mixing 60 per cent. with 40 per cent. of any gas or soft bituminous slack or screenings available, then pulverizing, and burning it in suspension.

Use of Fine Anthracite at Mines

The ideal means for preparing and disbursing this fuel would be to install preparation plants at the collieries, from which both locomotives and stationary-power plants could be supplied, thereby relieving railway facilities, locomotives and cars otherwise required for its transportation.

*From paper contributed to the Fuel Session, Spring Meeting, American Society of Mechanical Engineers, June, 1918. 1918.

[1]President, Locomotive Pulverized Fuel Company, New York. Member A. S. M. E.

[2]Lehigh Valley Coal Company.

W. S. HACHITA:[2] The anthracite industry is located in the northeastern part of the State of Pennsylvania. The area underlaid with anthracite is approximately 800 square miles. Roughly, the field is divided into four parts: The northern field, comprising the Carbondale, Scranton, Wilkes-Barre and Nanticoke districts; the northern middle field, or Hazelton district; the southern middle field, including Mahanoy City, Shenandoah, Mt. Carmel and Shamokin; and the southern field, consisting of Lansford, Pottsfield and Tremont districts.

In preparing anthracite, there are two kinds of waste produced: First, fine material, the largest pieces of which are no bigger than 3-32 in., which is so fine that, heretofore, it has been considered unmarketable; second, rock refuse. The latter material has been picked out during the process of preparation. The production of culm at present is approximately 7½ per cent. of the total output.

Amount of Culm Production in Tons

The average culm production from the beginning of the industry to the present time (1820-1918) is about 15 per cent. of the tonnage mined. According to the statistics the anthracite mined and shipped from 1820 to Jan. 1, 1918, amounted to 2,332,673,250 tons, so that the amount of culm produced during the same period was 349,901,000 tons. Out of this, about 50 per cent. has been taken into the mines to support the roof and washed away, leaving 174,950,000 tons available above ground in the whole anthracite field.

The rock refuse, which consists of slate and bony coal, amounts to approximately 10 per cent. of the output, or about 233,267,000 tons. The slate that occurs in anthracite shipments is entirely unlike that used in roofs, sidewalks, etc. On the other hand, it contains from 28 to 48 per cent. of combustible material, while the bony material contains from 45 to 70 per cent. of combustible. The rock banks, composed of slate and bone, contain at least 50 per cent. of the heat in commercial anthracite. At the present time, rock refuse is not utilized as fuel in the anthracite field.

The fine material which is locally known as culm slush, or silt, contains 70 to 85 per cent. of combustible material. It is therefore a good fuel, provided proper means of burning it can be used.

Mixtures of Soft Coal and Culm

The first series of tests consisted of 30, 50, and 70 per cent. of run-of-mine coking coal mixed with 70, 50 and 30 per cent. of culm from the Hazleton Shaft Colliery of The Lehigh Valley Coal Co. The second set of tests consisted of a mixture containing pulverized bituminous coal. The biggest pieces of soft coal in the mixture were not larger than 2 in. in diameter. Both fuels were thoroughly mixed in the proportions cited by the use of shovels, and fired. The result of these tests shows that in every case the pulverized bituminous coal produced the better results.

The noncoking bituminous coal was also tried, but it did not give the same result as that produced by the coking coal. The reason why the coking coal is better adapted to mix with the culm lies in the fact that it fuses at a comparatively low temperature and the fusion takes up the particles of culm, forming a homogeneous mass of fuel, which burns uniformly. The results of these tests show that a mixture consisting of 30 per cent. of culm and 70 per cent. of coking bituminous coal produced a water evaporation equal to that given by the straight bituminous coal. It was also noticed that the mixture was easier to burn than soft coal alone. This is because, when soft coal alone is burned, the fuel bed becomes a hard, coked mass requiring considerable poking to effect complete combustion, whereas in the case of the mixture the coked fuel is more easily handled by the fireman. It was also noticed that the fuel produced little smoke.

In September, 1917, E. E. Loomis, president of the Lehigh Valley Railroad Co., was informed by F. M. Chase, vice-president and general manager of the same company, about the formula of the mixed fuel with the view of burning the

mixture on stoker engines. It was then decided to try it on big freight locomotives running between Hazleton and Lehighton, a distance of 26 miles. In this test the fuel consisted of 30 per cent. culm and 70 per cent. of stoker coal or slack. The train was made up of 50 cars of coal hauled from Hazleton to Lehighton and returned to Hazleton with 65 empty cars. There was no trouble experienced in the test and in evaporation tests made on locomotives using the mixed fuel and straight bituminous coal.

More Steam with Mixed Fuels

The results of these evaporation tests showed that the mixed fuel produced approximately 30 per cent. more steam than straight bituminous coal, although the calorific power of the latter was considerably greater than that of the mixed fuel. This is due to the fact that the complete combustion of the hydrocarbon is possible in the mixed fuel, whereas, in burning straight bituminous coal the greater part of these valuable hydrocarbons are lost as smoke.

B. S. Murphy:[3] Our plant was designed to use the small sizes of anthracite coals, and under normal conditions we have no difficulty in doing so even with the No. 4, or dust. The increase in the impurities with a relative decrease in calorific value due to colliery methods, such as mining, failure to wash in the larger sizes such as No. 1, the large amount of shale and pebbles in the so-called river coals, dredged coals, etc., has placed a different aspect on the problem, but one that can be solved successfully for such plants as are now equipped or will procure the necessary equipment.

The coal used varies from straight No. 1 buckwheat to No. 3 and No. 4, the latter, or dust, using the recommended A.S.M.E. scale, being that passing through a 3-32-in. opening, our so-called No. 3 having from 45 to 60 per cent. dust and the No. 4 over 60 per cent. and up to 85 per cent. through 3-32-in. screen.

Influence of Size of Coal

It is most desirable from both an economic and an operating standpoint to adhere to one size of coal for as long time periods as possible. It is impossible to maintain good economy when the run of coal for the boilers changes continually from the smaller to the larger size and back again, for an entirely different method of manipulation is necessary. On the other hand, if the fuel is a well-mixed one, say, 15 per cent. of No. 1, 20 per cent. of No. 2, 40 per cent. of No. 3 and 25 per cent. of No. 4, and remains as such, it can be handled well and in fact is easier to handle than the No. 3 for poor firemen.

The reason for the mixture of bituminous coal with the anthracite is twofold, (a) to act as a binder and (b) to increase the calorific value. With the large size, No. 1 buckwheat, our practice is to add no soft coal. Here we find that the soft coal is a detriment, forms clinker with the impurities and makes the firing more difficult.

With the small sizes the primary function of the good coals—11,500 B.t.u. to 12,000 B.t.u.—is to act as a binder to hold the fire on the grates, and with the poor coals to increase the calorific value as well.

The amount necessary to bind the fuel varies from 5 to 10 per cent., say 7.5 per cent., as a mean; this again will depend, however, on the quantity of the No. 4 size. The smaller the coal particles the greater the amount of bituminous required, until with the straight No. 4, say 80 per cent., from 15 to 20 per cent. should be used.

Another use for the bituminous coal is the "building of bottoms" in the fire and the repairing of holes. This is especially true with the untrained firemen, and our practice is to have a small bunker of bituminous on the fireroom level where the men can get a few scoopsful from time to time for this purpose.

Mixing Anthracite and Bituminous

It is of the utmost importance to have the bituminous well mixed with the anthracite, for the better the mixture the less required and the better the economy. In small plants where the coal is brought to the fires in barrows, it should be turned in on the floor similar to mixing concrete.

Our practice at the present is crude and consequently does not give the best results. The coal is delivered in hopper-bottom cars; a predetermined number of buckets of bituminous is added from a storage pile on top of the car, by means of a locomotive crane. The coal is then dumped on conveying belts delivering the mixture to a crusher and thence to the overhead bunkers. In the summer this method works fairly well, but in the winter, with the coal frozen, the soft coal may be delivered to the bunkers some 30 or 40 min. before the coal in the car is all unloaded, because the pockets thaw first and the soft coal goes through a long while before the ends of the car thaw enough to flow. This results in uneven distribution about the boilers, some chutes having far too much soft and others not enough. Here again the emergency bunkers on the fireroom level come into play.

Considerable Soot Is Formed

An element that enters into hand firing of small anthracite sizes is the vast formation of soot or flue ashes. It is necessary to carry considerable draft, and the result is that some of the combustion is similar to that of powdered fuel; it never reaches the grates after leaving the fireman's shovel; it either ignites and burns in the air or is brought over to the rear connections in the form of coke. The greater the rating the larger the soot deposits due to the greater draft necessary; but even working the boilers at light loads, a very large amount is formed. Our boilers were designed with this in view and have a large space in back of the bridge-wall to allow this soot to accumulate, and soot pipes extending down into the ash cellar to allow it to run directly into the ash cars; our economizers are also equipped with soot pipes for this purpose. With the No. 4 coal and insufficient soft coal in the mixture, we will build up soot four or five tubes high between cleanings of soot hoppers, or in six hours.

To give an idea of the magnitude of this, we have had months when the weight of the soot removed was 10 per cent. of the weight of the coal fired; this is exceptional, and it should be from 6 to 7 per cent. It may be of interest to note that at times an analysis of the soot shows a slightly higher calorific value than the coal it was made from, owing to the fact that the soot is principally coked coal without impurities. We have attempted to burn this but with no success. However, if a small briquetting plant with a cheap binder were available, it could be done successfully. The soot formed by the stoker is naturally but a small percentage of that in the hand-fired boiler.

The grates are the inclined-dumping type, with an area of 190 sq.ft. per boiler of 900 hp. The air spaces are 20 per cent. with one and 9 per cent. with the other.

Thickness of the Fire

Our practice is to carry as thin a fire as possible without danger of blowing through and forming holes. The thickness of fire hinges on the formation of a good bottom after cleaning, say about 3 to 5 in. thick, and then building up as slowly as possible. We clean before the service hour and start cleaning again as soon as the peak is over—some two hours if the fires will stand that long. The thickness of the fires at the time of cleaning is uncertain, depending on the load carried and the coal; we have had them from 20 to 24 in. or even heavier, but 16 to 18 in. will be nearly an average.

The amount of draft available is of the utmost importance as it is impossible to use the small sizes without a high ashpit pressure. At our Terminal Building in New York we can carry the normal load, somewhat below boiler rating, with natural draft, but here, on account of the great height of the stack, about 320 ft. above the top of the grate, we have an unusual condition; when the boilers are brought to rating the natural draft has to be augmented by blowers. At the Jersey City Power Station we use from 2½ to 3 in. water gage between loads and from 4 to 7 in. during the peaks, depending on the load and the condition of fire.

The rate of combustion varies with the load and coal. During our peak hours, with poor coal we burn from 40 to 60 lb. per sq.ft. per grate per hour, while for the whole 24 hours the rate will be from 20 to 25 pounds.

We have but one stoker installed at the present, a Coxe

[3]Superintendent of Motive Power, Hudson and Manhattan Railroad, Jersey City, N. J. Member A. S. M. E.

(chain-grate), but we are now equipping all of our hand-fired boilers with this type of stoker.

Handling Frozen Coal of Fine Grades

An important consideration in the use of culm for fuel is the thawing of coal during the winter months if the coal is delivered to the plant in cars. On account of its compactness the moisture freezes to a hardness equal to that of lean cinder concrete and a dull-point chisel is necessary to cut it. If a thawing house is not available, special provisions will have to be made. Our practice is to use from 8 to 12 thawing pipes per car, 1¼-in. extra-heavy pipe fittings with cap and tee at upper end, a drive point at the lower end and the lower portion of the pipe above the drive point perforated with a large number of small holes. The pipes are entered in the top of the pile in the car and after the thawing begins are driven down from time to time with a wooden maul. The pipes connected in series are fed with 140 lb. superheated steam. It requires from two to six hours for this, and then the car is brought over the unloading hopper. The car hopper will be iced so badly that it also will have to be thawed, especially the operating mechanism. To do this we use portable nozzles made up of three 1-in. pipes clamped together with a common steam connection to a rubber steam hose, the outlets of the pipes staggered to make an equilateral triangle and bent at right angles to the body of the pipe. This will thaw the car-door mechanism within a few minutes, so that the doors can then be opened. The worst frost will be found here on account of the drainage accumulation at the low parts, but about ten minutes with two nozzles will start the coal running in the worst car, opening a hole to the top of the car and allowing the coal thawed by the top pipes to run out. It must be borne in mind, however, that this will require a large amount of steam; we find this equivalent to 10 tons of coal per 24-hour day for from 12 to 18 cars unloaded. It is also necessary to have quite a gang of men working in the car; we use from 4 to 8 to the car because considerable picking is necessary where the coal adheres to the metal sides of the car.

G. H. Sharpe:[4] The Derby Gas Co., Derby, Conn., endeavor to provide, during the season of open navigation on the Housatonic River, an ample reserve stock of bituminous coal to carry the electrical department through the winter and early spring. The demands during the past winter exceeded the estimate, owing to the emergency power supplied to Waterbury, Conn., and to tide over it was decided to accept an offer of about 11,000 tons of No. 2 and No. 3 buckwheat, on which deliveries started in the latter part of March. The 11,000 tons were purchased under three contracts, the average analysis of which is about as follows: Ash, per cent., 20.52; moisture, per cent., 8.20; B.t.u. dry, 11,587; B.t.u. as received, 10,638.

How the Mixture Is Obtained

An average of 7000 lb. of buckwheat is loaded from the storage pile into a truck, and the truck is then filled up with bituminous, giving about 55 per cent. of buckwheat per load. This is dumped at the power station, passing through a crusher and conveyor, and into the bunkers, resulting in a uniform mixture. From the overhead bunkers the coal is delivered through a traveling-weigh larry to multiple-retort underfeed stokers serving two 600-hp. B. & W. boilers. The mixture is, as stated, about 55 per cent. No. 2 and No. 3.

The fire carried is much thinner than with bituminous, and with 2½- to 3-in. draft. The output of the boiler is reduced because of the lower heat value of the fuel.

The clinkers and ash are increased, resulting in a marked increase in cost of operation, as ashes are loaded by hand to trucks, pending completion of the new boiler room; but clinkers are more easily broken, so that less coke is lost.

We are burning 2.20 to 2.21 lb. of coal per kilowatt hour at the switchboard, with a maximum output of 6800 kw. and an average of between 5000 and 5500 kw., giving an over-all plant efficiency of about 11.9 per cent.

The buckwheat costs $1 less than the bituminous, but the increased cost of ash disposal and lower heat value do not warrant additional purchases. The stokers handle the 55 per cent. mixture readily, and I have no doubt that we could have made an equal showing, based on heat values with 75 per cent. or even 85 per cent. of buckwheat.

W. G. Diman:[5] We have at the plant of the Amoskeag Manufacturing Co., 185 boilers of which 169 are running today; all boilers are fitted with underfeed stokers. About two years ago we began to get small quantities of anthracite screenings and refuse; the amount has been increasing until we are now burning hard coal of No. 2, No. 3 and bird's-eye sizes straight under 135 boilers, and hard coal mixed with a small percentage of soft coal under the others.

When we began to receive the hard coal, we experimented with various mixtures, but finally used the fuel straight on each to get comparisons of the various grades to assist us in buying. We found that with the regular installation of the Jones stoker the coal was pushed over on to the dead plates and lay idle there with no chance for air to mix and consume the coal. When the buckwheat was hot, it acted like sand and the tuyere blocks on the side of the retorts had a tendency to blow the coal over to the side and pile it up. In order to make an even fire and to get better distribution of air for burning, we put in pin-hole dead plates with about 270 one-quarter inch holes, or a total increased air area of about 4 in. The plates were not faced off but were rough castings, which allowed considerably more air to get into the fire. I think still better results would be obtained if we should cut off some of the air spaces in the tuyere blocks and add this air space in the dead plates. This would reduce the open spaces in the bed caused by the tuyeres blowing away the coal and produce a more even fire. Some of the coal drops into the pits, which have to be cleaned out to prevent their burning and forming explosive gases.

Draft and Thickness of Fire

We carry a light fire, about 6 in. to 8 in. thick, which allows the air to get through. About 2 in. water pressure is carried at the tuyere blocks and no draft in the uptake. We burn about 600 lb. of coal per hour, or about 26 lb. of coal per square foot of grate.

We have had to run anthracite coal as high as 25 per cent. in ash. When doing this we have considerable trouble with the fires and handling the ashes. We find that the more we handle the fires the greater the loss. We cannot get efficient results out of coal containing much more than 20 per cent. ash, and if we should get coal containing 40 per cent. ash it would be useless to us. In view of the transportation problem and freight rates, the place to burn any coal having about 25 to 30 per cent. ash is at the mines, where they can equip to burn the specific fuel which is produced.

The following notes show what results we obtained from our tests, all of which ran 12 hours. Each lot received is tested before and during shipment.

An average of 20 tests of straight soft coal of different qualities gave an efficiency of 76 with an evaporation from and at 212 deg. per lb. of dry coal of 10.7 lb. The ash averaged 8 per cent. These tests were made without any perforations in the dead plates.

One test of mixture made with two-thirds soft coal and one-third buckwheat gave an efficiency of 74.7 per cent. with an evaporation of 9.93 lb. from and at 212 deg. per lb. of dry coal; and the ash averaged 11.4 per cent. This gave a good fire, but of course required a little more work and attention from the firemen. The load could be easily carried under these conditions.

An average of two sets of mixture made with one-half bank coal and one-half soft coal gave the following results: Efficiency, 58.3 per cent; evaporation from and at 212 deg. per lb. of dry coal, 6.97 lb.; ash, 19.73 per cent. This coal was somewhat dirtier than the average and required considerable work from the firemen. We burned about 670 lb. of coal per hour and ran about 93 per cent. of the boiler's rating. The results of all our tests with culm proves that it is much below buckwheat and smaller sizes in evaporation, and the only way to get it on a basis with buckwheat is to increase the soft coal percentage, which of course increases the mixture price. It would take three parts soft to two culm to equal two parts buckwheat and one soft.

[4]Derby Gas Co., Derby, Conn.

[5]Supt. of Power, Amoskeag Mfg. Co., Manchester, N. H.

An average of two tests made with a mixture of two-thirds buckwheat and one-third soft coal gave an efficiency of 66.2 per cent. with an evaporation of 7.96 lb. of water from and at 212 deg. per lb. of dry coal; ash, 14.83 per cent. These two tests were made on a little better grade of bank coal. We burned 676 lb. of coal per hour, and obtained 95.1 per cent. of the builder's rating. The boilers are of 150 hp. each. We used a draft in the tuyere blocks of 1.59 in. and 0.07 in. in the uptake. When using this mixture, the fire burns well but needs close attention. A light fire must be carried.

An average of eleven tests of anthracite refuse, which includes bank coal and culm (no soft coal used), gave the following results: Efficiency, 55.7 per cent.; evaporation from and at 212 deg. per lb. of dry coal, 6.75 lb.; average ash, 17.8 per cent. We consumed 628 lb. of coal per hour, obtained an average of 78.4 per cent. of the builder's rating and used 1.86 in. of water pressure at the tuyeres. This was an experimental mixture made to see what it would do.

An average of seven tests with prepared anthracite screenings of No. 2 and No. 3 buckwheat and bird's-eye without any soft coal gave the following results: Efficiency, 59 per cent.; evaporation from and at 212 deg. per lb. of dry coal, 7.47 lb.; average ash, 14.5 per cent. We consumed 742 lb. of coal per hour, obtained 96.7 per cent. of the builder's rating and used 1.73 in. of water pressure at the tuyere blocks.

We made one test using one-half culm and one-half buckwheat, which gave an efficiency of 53.2 per cent. and obtained an evaporation of 6.13 lb. from and at 212 deg. per lb. of dry coal. The ash averaged 21½ per cent. We consumed 680 lb. of coal per hour and obtained 72 per cent. of the builder's rating. To do this we used 1.87-in. draft at the tuyeres.

Price Limitations of Mixtures

Some of the buckwheat clinkers, and some of it will break up into smaller pieces, mixing with the fire, which makes it hard to clean. The fire should be disturbed as little as possible. It is not good judgment to use a slice bar more than is necessary. The fires should be kept medium, and the hoe should at all times be able to touch the grate. When hot, this class of coal resembles sand and a hoe can easily move it when necessary and handle the dirt. The lighter the fire the better are the results. Unless the firemen are watched, they tend to carry heavy fires with more draft. With an 8-in. fire we can easily burn 1000 lb. of coal per hour using a 2-in. draft at the tuyeres.

We can burn screenings successfully if we obtain 20 per cent. soft coal. It is more economical to burn straight soft coal than screenings, unless the equipment is installed for the burning of this class of coal. Two years ago last April we ran on soft coal only. We burned that month 10,352 tons of coal as against 13,689 tons of practically hard coal (about 20 per cent. of soft coal) this last April. Our steam load this year was 369,512 kw. hr. less for the month of April, or about 12 per cent. of the total steam load.

If we take hard coal at $6.25 per ton and soft at $10, it would make the balance in favor of soft coal, provided the load was the same and we took into consideration the added cost for boiler-house labor and handling ashes.

We recently received a cargo of Dominion coal which apparently is high in volatile. We burned this with buckwheat, a quarter of Dominion soft coal and the rest buckwheat, and we secured the best results that we have ever had. Dominion coal burned straight is poor coal because it clinkers badly, but it has a tendency to mix with anthracite, and the anthracite holds down the volatile elements.

WILLIAM P. FREY:[6] There is only one kind of anthracite waste, and that is material containing 35 per cent. or more of incombustible, be it chestnut coal or No. 4 buckwheat. Since the development of the process of cleaning No. 4 buckwheat (through ⅛-in. round mesh and over 1/16-in. round mesh) and No. 5 buckwheat (through 1/16-in. round mesh) these two products have gained a firm foothold and have come to stay.

No. 3 buckwheat and No. 4 buckwheat are two excellent stoker fuels if there is a proper stoker installation. No. 5 buckwheat is too light for stoker firing and should be briquetted. To the users of soft coal, hand- or stoker-fired furnaces, I cannot too strongly recommend mixing No. 3 buckwheat or No. 4 buckwheat with bituminous coal.

Firing of Anthracite Buckwheat

Table 1 represents the attempt to tabulate in an easily understandable form the practical operating condition of industrial power plants with highly varying loads. As it was found that a rate of combustion of 25 lb. of dry coal per square foot grate surface was very economical for all sizes, this rate was adhered to as closely as possible by adjusting the speed of the grates and the air supply. As a rough guide for the boiler operatives the blowers have to be set to deliver 20 cu.ft. of air per maximum horsepower. The air control goes hand-in-hand with the CO_2 recorder readings that read 12 per cent. on the average and the stack temperatures which are to be kept below 500 deg. F. If the stack temperatures are high, the speed of the grate must be increased, the thickness of the coal fuel bed reduced, the air pressure under the grate lowered, but the rate of combustion maintained as constant as possible. It is very important to understand that the figures given in the column for grate travel in feet per hour are relative to 25 lb. of coal per square foot which means that if the grate runs at 16.2 ft. in case of No. 3 buckwheat, the bed must be carried 6 in. thick. If it is desired to carry only 4 in., the speed of the grate must be increased 6 : 4 = 1.5 times to keep the same rate of combustion. It has to be understood, too, that 25 lb. per sq.ft. is by no means the highest possible rating. The maximum rating obtainable according to our experience is: No. 1 buckwheat, 40 lb. per sq.ft. per hour; No. 2 buckwheat, 35 lb. per sq.ft. per hour; No. 3 buckwheat, 30 lb. per sq.ft. per hour; No. 4 buckwheat, 27 lb. per sq. ft. per hour; unclean silt and No. 5 buckwheat, 25 lb. per sq.ft. per hour or less. These figures apply to a Coxe stoker with 7 per cent. air space.

TABLE 1. OPERATING RESULTS OF ANTHRACITE BUCKWHEATS

750 Hp. Maxim Boiler—Coxe Traveling Grate. Average Steam Pressure 125 Lb.

	No. 1 Buckwheat	No. 2 Buckwheat	No. 3 Buckwheat	No. 4 Buckwheat	Uncleaned Silt
Average hp. of test	1,500	1,395	1,200	1,010	495
Maximum hp. of test	1,750	1,600	1,400	1,100	650
Average per cent. rating	200	186	160	134	66
B.t.u. per lb. of dry coal	12,250	12,000	11,500	11,000	10,000
Combined efficiency of boiler, furnace and grate	74	70	65	61	45
Equivalent evaporation from and at 212 deg. per lb. of dry coal	9.35	8.77	7.7	6.9	4.6
Dry coal consumed per hp. per hour	3.69	3.93	4.48	5.00	7.5
Dry coal per sq.ft. grate surface per hour	25	25	25	25	25
Boiler hp. per sq.ft. grate surface	6.8	6.36	5.5	4.9	3.3
Grate travel in ft. per hour	16.6	16.5	16.2	15.2	11.1
Cost per hp. per hour in cents	0.67	0.58	0.43	0.27	0.21

Note—Last figures correspond to prices at the mines and have to be adjusted to meet the various freight rates.

The operating equipment includes automatic feed-water and damper regulators, recorders of steam flow, CO_2, feed-water temperature, steam pressure and stack draft; draft gages and long-distance thermometers.

Firing of Anthracite and Soft Coal Mixed

Buckwheats No. 3 and 4 are well adapted for mixing with soft coal if they are clean and the mixing is well done. These two conditions are absolutely essential and cannot be emphasized enough. The method of firing need not be changed, although there should be a tendency to fire thin and to damp off. The green coal should be thrown on when the fire is white-hot, after leveling, for instance, and then there will be a very pronounced coking effect that will bake the No. 4 buckwheat to a coarsely granulated fuel of about pea-coal size. The fire must be kept loose at all times and will stand very hard blowing. Almost any good grade of grate bar is suitable, up to about ¾-in. openings, provided enough kindling is left on the grate after cleaning to cover the grate. The most gratifying feature of the mixture burning is that it does away with all hard clinkers, which is especially welcome in stoker practice, particularly in underfeed stokers.

[6]Fuel Engineer, The Lehigh Coal and Navigation Co., Lansford, Pennsylvania.

New Publications

CIRCULAR NUMBER 73 OF THE BUREAU OF STANDARDS

This is the first of a series of circulars to be issued by the Bureau in answer to numerous requests for detailed or general information, concerning the properties, statistics, etc., of metals and of alloys, coming from various sources. Such information is rarely found in systematic form; generally the different sources of information are difficult of access, and their accuracy is not always certain. The endeavor in these circulars is to produce only such data as have passed critical scrutiny and to suitably qualify all statements, numerical or otherwise, made relative to the characteristics of the metal. The circular on copper is standard size (7 x 10 in.) 103 pages with numerous illustrations and graphic charts and is obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 20 cents per copy.

Personals

Jos. J. Nelis, for the past 15 years connected with various departments of the Babcock & Wilcox Co., has accepted a position with the boiler division, technical department of United States Shipping Board, Emergency Fleet Corporation, Philadelphia, Penn.

F. A. Mansfield, who has been connected with the export and industrial departments of the Westinghouse Electric and Manufacturing Co. for the last 12 years has resigned to become manager of the Pittsburgh office of a new company known as the Mechanical Appliances Co., of Milwaukee.

Charles W. Burrows, Ph. D., magnetic-research engineer, Grasmere, Borough of Richmond, New York City, formerly chief of Magnetic Section, National Bureau of Standards, announces the establishment of a well-equipped laboratory in which he will continue his scientific investigations on the properties of magnetic materials and on the performance of magnetic devices.

John A. Kerley, past national president of the N. A. S. E., and for the last twenty-one years chief engineer, vice-president and general manager of the City Ice Delivery Co., of Cincinnati, Ohio, has taken service with the Dearborn Chemical Co. He will be located at the Cincinnati office and will cover a part of the State of Ohio. His long experience in the engineering and ice-making business is well known.

Engineering Affairs

Minnesota State Association, N. A. S. E., will hold its annual meeting at Duluth, Aug. 14-16, with headquarters at the Spaulding Hotel.

The Association of Iron and Steel Electrical Engineers will hold its 12th annual convention at the Southern Hotel, Baltimore, Md., Sept. 9-14. The tentative program of papers to be presented is as follows: Papers by the Standardization, Safety and Electrical Development Committees of the association; "Methods of Education for Electrical Employees of Iron and Steel Mills," prepared by the Educational Committee; "Remote-Controlled Substation," by W. T. Snyder; "Automatic Engine Stops," by Walter Greenwood; "Standardization of the Rating of Large Steel-Mill Motors," by K. A. Pauly; "Practical Method of Selecting Carbon Brushes," by Alfred Mullhaupt, Jr.; "Bridge Motors for Cranes," by R. H. McLain; "Condensers and Condensing Engineering Practice," by D. D. Pendleton; "Roller Bearings for Cranes," by P. B. Liebermann; "Installation and Operation of Auxiliary Drives," by J. D. Wright; "High-Tension Installations Under Severe Conditions," by James Farrington; "Electrically Driven Mills, Showing Tonnages, Costs, etc.," by J. T. Sturtevant, and "60 Cycles versus 25 Cycles for Steel Mills," by J. E. Fries.

Miscellaneous News

Surveys Have Been Completed of the Wabash, Mississinewa and Eel Rivers and Big Pipe Creek, near Peru, Ind., for water power for the City of Peru. The survey was made by W. H. Bassett, hydraulic engineer, of Springfield, Ohio. The city council of Peru will consider the erection of a power plant along one of the streams named. It is estimated that the Mississinewa River, at a point four miles east of Peru, will provide 250 hp. from water impounded by a 25-ft. dam.

A Steam-Electric Power Plant of 90,000 kw. capacity is to be constructed shortly at Philadelphia, to meet a possible shortage of power at Hog Island and other shipbuilding centers in that section of the country, as recently announced by Charles Piez, vice president of the Emergency Fleet Corporation. The estimated cost of the proposed plant is $11,000,000, and it is understood that the Philadelphia Electric Co. has offered to construct the power-producing facilities to supply the load if the financial support of the Government is granted.

Chippewa Canal to Yield 300,000 Hp.—The announcement by Sir Adam Beck, chairman of the Ontario Hydro-Electric commission, that work on the Chippewa Canal at Niagara Falls would be hurried to completion was followed recently by the beginning of actual operations on the new channel.

The canal, running from Chippewa Creek, above the cataract, will have an outlet below Queenston Heights, giving the flow of water a drop of about 300 ft. and sufficient head to develop 300,000 hp. The work will be pressed, Sir Adam Beck announced, to bring relief to war munition plants in Buffalo that are now short of power. He had nothing to say in regard to a congressional inquiry as to whether the new diversion would carry Canada beyond treaty limits to 36,000 cu.ft. of water a second at the Falls.

Niagara Power for War Purposes.—According to the War Department practically all power now available from Niagara Falls, whether generated in this country or imported from Canada, is being used to aid the prosecution of the war. Some of the shortage will be relieved by the proposed enlargement of the steam plants of the Buffalo General Electric Co. and the Niagara, Lockport & Ontario Power Co. Additions to to these two plants will aggregate 62,000 hp. By further developing the plants of the American Hydro Power Co. at Niagara Falls, their existing supply of 250,000 hp. will be increased by about 165,000 hp.

To Ask Congress for Power-Plant Financing—According to William Potter, Federal Fuel Administrator of Pennsylvania, plans have been made to ask Congress for $200,000,000 to finance the erection of large electric central power plants in various parts of the United States to meet the need of the country's war industries. This proposed legislation is in line with the efforts of the National Fuel Administration to conserve coal, transportation and supply of electric power. The territory most affected embraces, it is understood, Pennsylvania, New York, New Jersey, parts of Ohio, Northwest Virginia and New England indirectly.

Business Items

The National Pipe Bending Co., of New Haven, Conn., announces that it has entered into an agreement with Franklin Williams, Inc., of 39 Cortlandt St., New York City, to act as its representative in New York City and vicinity. F. N. Currier is president of the company and E. T. Franzen, secretary and treasurer.

The Lyons-Atlas Engine Co. of Indianapolis, and the Hill Pump Co., of Anderson, Ind., have become consolidated under the name of the Mid-West Engine Co. John G. Woods, formerly general manager of the Remy electric division of The United Motor Corp., has been appointed president and general manager of the new company, which wil specialize in turbine engines needed in large quantities by the United States Fleet Corp.

The Quigley Furnace Specialties Co., Inc., has opened a branch office in Pittsburgh, Penn., at 427 Oliver Building, to handle the sale of powdered-coal equipment and Hytempite furnace cement. The powdered-coal engineering department will be in charge of L. V. Marso, formerly maintenance engineer of the A. M. Byers Co. plant at Girard, Ohio, and the specialties department will be taken care of by J. L. Cummings, Jr., formerly connected with the sales department of the company at New York.

Trade Catalogs

Francke Flexible Couplings. Smith-Serrell Co., Inc., New York City. Bulletin No. 26. Pages 11, 6 x 9 in.; illustrated.

Buffalo Stationary Forges. Buffalo Forge Co., Buffalo, N. Y. Bulletin No. 108. Pages 32; 5 x 7½ in.; illustrated; indexed.

New Construction

Proposed Work

Mass., Amherst—The Massachusetts Agricultural College will soon receive bids for the erection of a turbine house. J. H. Ritchie, 8 Beacon St., Boston, Arch.

R. I., Providence—The Revere Rubber Co., 355 Valley St., is having plans prepared by Lockwood, Greene and Co., Boston, for the erection of various additions to its factory including a power plant.

N. Y., Cobleskill—D. D. Frisbee, Pres. of the Board of Trustees, Home Economics Bldg., Schoharie State School of Agriculture, rejected bids for the installation of a heating system, electrical work, etc., in connection with the construction of a school.

N. Y., New York—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until July 29, for an electric lighting and power system in shipbuilding slip No. 2. Estimated cost, $20,000. Noted July 9.

N. Y., New York—N. Klein & Co., 208 Centre St., is in the market for generators.

N. Y., Syracuse—The Semet-Solvay Co., Milton Ave., plans to rebuild its boiler house which was recently destroyed by fire. E. L. Pierce, Vice Pres.

N. J., Elizabeth—The Duesenberg Motors Corporation, 120 Broadway, New York City, is having plans prepared by J. M. Didrickson, Engr., for an extension to the boiler house on Newark and North Aves., here.

Penn., Lykens—The American Briquetting Co., Drexel Bldg., Philadelphia, is in the market for motors, conveyors, etc., in connection with its proposed 1-story, 50 x 225 ft., briqueting plant to be erected here. K. Dodge, 1512 Morris Bldg., Philadelphia, Arch.

Penn., Nicetown (Philadelphia, P. O.)—The Midvale Steel Co., Widner Bldg., Philadelphia, will soon award the contract for the erection of a 1-story, 53 x 120 ft. electric station here.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will soon receive bids for the installation of air compressors at the Navy Yard here. Noted July 16.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install electric driven capstans here. Specification No. 3172. Estimated cost, $21,000.

Penn., Philadelphia—The Pennsylvania Equipment Co., Crozer Bldg., is in the market for a 20-30 ton electric hoist.

Md., Indian Head—The Bureau of Yards and Docks, Navy Dept., will soon receive bids for installation of boilers and superheaters at the nitrate plant. Estimated cost, $200,00. Noted July 18.

Va., Norfolk—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install electric driven capstans here. Specification No. 3172. Estimated cost, $21,000.

Ala., Mobile—The Merchants Bank, St. Francis St., will install a low pressure steam heating system in its proposed 1-story, 50 x 120 ft. bank building. Total cost, $150,000. Friedstein & Co., 53 West Jackson Blvd., Engr.

Ala., West Blockton—The Blockton Mining Co. is in the market for a 50 h.p. shaft operation electric hoist with rope speed, 400 ft. per minute.

Miss., Sardis—The Panola Electric Light and Power Co. plans to rebuild its plant which was destroyed by fire.

La., New Orleans—The Bureau of Yadrs and Docks, Navy Dept., Wash., D. C., is in the market for boilers and superheaters. Estimated cost, $25,000.

Ky., Inez—The Dempsey Coal Co., Armor, W. Va., is in the market for boilers for installation in its mine in Martin Co. T. A. Sheeney, Supt.

Ohio, Cincinnati—The Hill Bruner Foundry Supply Co. plans to build various additions to its plant including a 1-story, 18 x 42 ft., brick boiler house. M. Fisher, Cincinnati, Arch.

Ind., Frankfort—The city plans to improve its electric light plant. R. H. Boynton, City Engr.

Wis., Marinette—The Aerial Cutlery Co. will install a steam heating system in its proposed 2-story, 35 x 120 ft. factory addition. Total cost, $15,000. D. Hubert, Menominee, Mich., Arch.

Kan., Baxter Springs—The Chilton Lead and Zinc Co. is in the market for oil engine, air compressors, belts, etc., in connection with the proposed concentration plant to be erected near here. Total cost, $45,000. F. Chilton, Supt.

Mo., Duenweg—F. Starkeweather, Webb City, will rebuild its concentration mill here, which was recently destroyed by fire. Equipment including boilers, engines, etc., will be installed in same. Estimated cost, $45,000.

Mo., Duenweg—The Vacation Mining Co. is in the market for boilers, engines, air compressors, belts, etc., in connection with the proposed concentration plant. Estimated cost, $65,000. B. Craig, Supt.

Mo., Granby—The Granby Consolidated Mining Co. is in the market for air compressors, boilers, engines, etc., in connection with the proposed concentration mills. Estimated cost, $13,000. W. G. Wilkerson, Atwood, Supt.

Mo., Holden—City is having plans prepared by Archer & Stevens, Engrs., 609 New England Bldg., Kansas City, Mo., for the erection of a new power house.

Mo., Joplin—The First Baptist congregation, 7th Ave. and Pearl St., will install a steam heating system in its proposed 1 and 2 story church. Total cost, $50,000. G. L. Hale, 516 West 9th St., pastor.

Mo., Joplin—Gurbel Bros., 6th and Main St. Kansas City, plans to install a steam heating system in its proposed 2-story, 100 x 150 ft., theater. Total cost, $55,000. C. Boller & Bros., 541 Ridge Bldg., Kansas City, Arch.

Mo., Joplin—F. Nicholson is in the market for air compressors, etc., for installation in the proposed concentration plant near Cresswell, Kan. Total cost, $33,000. O. W. Sparks, Supt.

Mo., Orongo—A. F. Holt will build a new concentration plant and rebuild its mill which was recently destroyed by fire. New equipment, including oil engine, belts, air compressors, etc., will be installed in same.

Mo., St. Louis—The Board of Public Service plans to install a hot water heating system in the proposed boys' cottages to be erected on Bellefontaine Farms. Estimated cost, $75,000. L. R. Bowen, City Engr.

Mo., St. Louis—The G. D. Hall Real Estate Co., 823 Chestnut St., is in the market for motors in connection with the proposed 4-story, 54 x 131 ft. factory. E. J. Hess, 3226 Magnolia St., Arch.

Mo., Waco—G. Ball is in the market for belts, air compressors, conveyors, etc., in connection with the proposed concentration plant to be built near here. Estimated cost, $60,000.

Mo., Waco—The Central Zinc Co. will install air compressors, belts, boilers, etc., in its mill near here. F. Danglade, Supt.

Mo., Waco—The Crescent Lead and Zinc Co. is in the market for air compressors, gas engine, etc., for installation in the proposed concentration plant to be erected in Waco Field. Total cost, $35,000. G. Smith, Supt.

Mo., Waco—The Miami Waco Lead and Zinc Co. is in the market for oil engine, compressors, etc., for installation in the proposed concentration plant to be erected in Waco Field. Total cost, $40,000. W. P. Cunningham, Supt.

Ark., Paragould—City plans to build an electric lighting and power plant.

Tex., Galveston—The Brush Electric Co., 2424 Market St., plans to rebuild its power plant on 26th and Postoffice Sts. W. R. Phipps, Gen. Mgr.

Okla., Century—The Crescent Mining Co. is in the market for conveyors, air compressors, belts, engine, etc., for installation in its proposed concentration plant. Total cost, $45,000. H. L. Woods, Supt.

Okla., Commerce—The Big Jim Mining Co. is in the market for conveyors, engine, air compressors, etc., for installation in its proposed concentration plant. Total cost, $60,000. G. W. Nesmith, Supt.

Okla., Commerce—The Safeguard Mining Co. is in the market for boilers, engines, etc., in connection with the proposed concentration plant. Estimated cost, $70,000.

Okla., Douthat—The Maurice Mining Co. is in the market for boilers, engines, conveyors, compressors, etc., in connection with its proposed concentration plant. Estimated cost, $75,000.

Okla., Lawton—The Development Co. plans to remodel and increase the capacity of its concentration plant. New equipment, including air compressors, engine, etc., will be installed in same. Estimated cost, $40,000. E. E. Sayne, Supt.

Okla., Miami—The Miami Wonder Mining Co. is in the market for belts, engines, boilers, air compressors, etc., for installation in its proposed concentration plant near St. Louis. Estimated cost, $60,000. A. V. Ellis, Supt.

Okla., Okmulgee—City receives bids about Sept. 1 for a new pumping station. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., Engr.

Okla., Picher—The Ottawa Metal Co. is in the market for boilers, air compressors, engines, belts, conveyors, etc., in connection with the proposed concentration plant to be erected near here. Total cost, $45,000.

Okla., Picher—The Picher Lead Co. is in the market for belts, engines, boilers, air compressors, pipes, etc., in connection with the proposed concentration plant to be erected here. Estimated cost, $60,000. G. Potter, Supt.

Okla., Quapaw—The Quapaw Jack Lead and Zinc Co. is in the market for air compressors, conveyors, belts, etc., in connection with the proposed concentration plant. Estimated cost, $65,000. B. W. Ward, Supt.

Okla., Tar River—The Maxine Co. is in the market for gas driven engine, air compressors, belts, conveyors, etc., for installation in its proposed concentration plant. Total cost, $85,000. W. C. Miller, Supt.

Colo., Brighton—The town is in the market for pumping equipment consisting of two 6-in. water meters, a 50-hp. centrifugal pump with 1000 gal. capacity, etc. R. D. Salisbury, 1415 East Colfax Ave., Denver, Consult. Engr.

N. M., Lordsburg—The Lordsburg Gold and Copper Co. is in the market for power and hoisting equipment for installation in its mine 4 miles from here. E. L. Armstrong, Supt.

Wash., Seattle—The Todd Dry Dock Co., 1801 16th Ave. S. W., plans to build a 2-story, 50 x 100 ft. power house. Estimated cost, $9000.

CONTRACTS AWARDED

Mass., Boston—The Boston & Maine R.R. has awarded the contract for alterations to the power station on Minot St. to W. N. Pike & Son, Essex St., Lawrence. Estimated cost, $16,000.

N. Y., Brooklyn—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received only bid installing boiler with mechanical stoker at the U. S. Naval Hospital Reservation, from the Heine Safety Boiler Co., 11 Bway, New York City, $23,350—100 days; alternate, $24,600—100 days.

N. J., Newark—A. W. Beaven, Pres. of the Board of Managers, New York State Custodial Asylum for Feeble Minded Women, received low bid for the installation of a heating system, equipment, etc., from W. S. Davendorf, Rochester, N. Y. Estimated cost, $31,500. Noted June 18.

W. Va., Mercers—The Mercers Mining Co. has awarded the contract for the erection of a power house and cottages, to the Charleston Concrete Constr. Co., 809 Union Trust Bldg., Charleston.

Ill., East St. Louis—The D. M. Oberman Manufacturing Co., Jefferson City, Mo., has awarded the contract for the erection of a 4-story, 60 x 160 ft. factory on 8th and Brady St. here, to H. Bancroft, Arcade Bldg. Estimated cost, $50,000; an electrical power system will be installed in same.

Kan., Garnett—The city has awarded the contract for a boiler, generator and engines to be installed in the water-works plant, to Merkle Machinery Co., 508 Interstate Bldg., Kansas City, Mo. Estimated cost, $21,379.

Okla, Chickasha—The State Board of Public Affairs, Oklahoma City, has awarded the contract for the erection of a 1-story, 40 x 42 ft. power house, to Campbell & Price, 61 Majestic Bldg., Oklahoma City. Estimated cost, $63,450.

Colo., Denver—The United States Government has awarded the contract for heating and power systems to be installed in the Denver General Hospital, to McCarty-Johnston Heating & Eng. Co., 1418 Curtis St. Estimated cost, $200,000.

Colo., Pueblo—City received bids for the completion of the heating and ventilating systems, etc., in the proposed auditorium and city hall, from C. S. Lambie & Co., Tramway Bldg., Denver.

Wash., Seattle—Armour & Co., 3d Ave. S. and Jackson St., has awarded the contract for the erection of an 8-story packing plant, to F. A. Leonard, Lewis Bldg., Portland, Ore. Estimated cost, $50,000; a large number of refrigerators will be installed.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current
Buckwheat	$3.40
Rice	2.90
Boiler	2.65
Barley	2.40

All-rail rate to Boston $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual
Pea	$5.20	$5.95
Buckwheat	5.15	5.90
Rice	4.65	5.10
Barley	4.15	4.30
Boiler	4.60	....
Broken	6.75	7.50
Egg	6.35	7.10
Stove	6.60	7.35
Chestnut	6.70	7.45

Quotations for domestic coals at the upper ports are 5c. higher on account of the differenec in freight rates. Prices for buckwheat, rice, barley and boiler are not fixed by the Government.

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b., Tidewater, at the lower ports, are as follows:

	Mine	F.O.B. N.Y.
Central Pennsylvania (Mine run, Prepared or Slack)	Gross $3.30	Gross $5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports are 5c. higher on account of the difference in freight rates.

The foregoing prices ar exclusive of the 3 per cent. war freight tax on both anthracite and bituminous.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.10	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.55-2.90	$2.55-2.70	$2.25-2.50
2-in. lump	2.55-2.90	2.55-2.70	2.25-2.50
Steam egg	.....	.....	2.25-2.50
Mine-run	2.35-2.50	2.35-2.50	1.90-2.10
No. 1 nut	2.55-2.90	2.55-2.70	.....
2-in. screen	2.05-2.20	2.05-2.20	.....
No. 5 washed	2.05-2.20	2.05-2.20	1.30-1.75

Williamson-Franklin rate to St. Louis is $1.10, other rates, $0.95.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam	$2.50	$2.80	$2.20
Cahaba, Black Creek, Brookwood, Blue Creek	3.20	3.45	2.80
Pratt, Jaeger, Jefferson, Nickel Plate	2.70	3.00	2.40
Corona	2.75	3.10	2.40

The above are Government prices per net ton of 2000 lb. mines and include the 45c. per ton allowed by the wage agreement, less 10c. reduction which was effective May 25, as a result of the agreement with the railroad administration for furnishing fuel coal.